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EDITED BY J. McKEEN CATTELL

CONTENTS

THE DEVELOPMENT OF MUSEUMS AND THEIR RELATION TO EDUCATION.
HARLAN I. SMITH 97

MINERAL RESOURCES IN WAR AND THEIR BEARING ON PREPAREDNESS.
Professor JOSEPH E. POGUE 120

SCIENCE AND AN ORGANIZED CIVILIZATION. Professor WM. E. RITTER . . 135

THE APPLICATIONS OF SCIENCE. Professor W. F. DURAND 146

RACE SUICIDE IN THE UNITED STATES. DR. WARREN S. THOMPSON . . . 154

THE PHYSIQUE OF THE ANCIENT HAWAIIAN.
Professor VAUGHAN MACCAUGHEY 166

RILLY, A FOSSIL LAKE. Professor EDWARD W. BERRY 175

THE PROGRESS OF SCIENCE:
Chemists and National Service; The Infant Death Rate and Social Conditions; The San Salvador Earthquake; Scientific Items 187

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A recent notable endorsement of this book occurred in Minneapolis. A Committee on General Science, representing each High School in the city, was asked to outline a course in Science for first year High School. After making the outline they considered the textbook situation. In this regard, the Committee reports as follows:

"We feel that, in Science, a book for first year High School use should be simple in language, should begin without presupposing too much knowledge on the part of the student, should have an abundance of good pictures and plenty of material to choose from.

Barber's *First Course in General Science* seems to us to best meet these requirements and in addition it suggests materials for home experiments requiring no unusual apparatus, and requires no scientific measurements during the course. We recommend its adoption."

Other Interesting Opinions on the Book Follow:

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WALTER BARR, *Keokuk, Iowa*:—Today when I showed Barber's Science to the manager and department heads of the Mississippi River Power Co., including probably the best engineers of America possible to assemble accidentally as a group, the exclamation around the table was: "If we only could have had a book like this when we were in school." Something similar in my own mind caused me to determine to give the book to my own son altho he is in only the eighth grade.

G. M. WILSON, *Iowa State College*:—I have not been particularly favorable to the general science idea, but I am satisfied now that this was due to the kind of texts which came to my attention and the way it happened to be handled in places where I had knowledge of its teaching. I am satisfied that Professor Barber, in this volume, has the work started on the right idea. It is meant to be useful, practical material closely connected with explanation of every day affairs. It seems to me an unusual contribution along this line. It will mean, of course, that others will follow, and that we may hope to have general science work put on such a practical basis that it will win a permanent place in the schools.

Henry Holt and Company

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THE SCIENTIFIC MONTHLY

AUGUST, 1917

THE DEVELOPMENT OF MUSEUMS AND THEIR RELATION TO EDUCATION

By HARLAN I. SMITH

GEOLOGICAL SURVEY, OTTAWA, CANADA

MANY of our people have been like the little girl, who on glancing around a museum said, "Mother, Why! this is a dead circus." They do not appreciate the real use and value of a museum. We do not wonder at it when we see the dusty, uninteresting, poorly arranged collections in many museums where there are few, if any, labels and the whole tends to disgust, in fact to exemplify disorder rather than to be pleasing, helpful or educational. People think these are fair samples of museums and so such museums tend to prevent our people from knowing how useful a museum may be and from wanting any museum.

Museums are warehouses of specimens. The specimens are stored, exhibited, or both stored and exhibited. The storing of specimens saves them for future students, and sometimes from total loss. The totem poles, for instance, may be burned or neglected by the Indians with change in their beliefs and mode of life, unless stored in museums. Some museums have phonographic archives containing large numbers of records of songs of various native tribes that are becoming extinct. No one has a moral right to horde in his home a specimen which is a key to knowledge that would be lost were thieves to break in his house or fire destroy it. Such specimens should be stored where they are available to all.

Museums are something more than warehouses, however. They are certainly, if slowly, evolving from warehouse collections of specimens used only by scientists, or of mere curios for the public gaze, to peerage with research institutions, schools, and libraries. Museums employ the methods of such institutions and they in turn all use museum methods. Museums

EXPEDITIONS ARE SENT OUT BY SCIENTIFIC MUSEUMS. Pack horse with Geological Survey, Canada.

EXPLORING EXPEDITIONS SOMETIMES USE PACK DOGS.

carry on researches, teach and have libraries. Research institutions, schools and libraries, all have museums.

The great museums are making admission free and are supported, as are schools and libraries, by taxes from all, or by gifts from successful business men who realize their value.

Dime museums are being forgotten. Collections of abnormal and ugly two-headed calves and three-legged chickens are of less interest and use than undeformed thoroughbreds which are of use and beauty. People have learned that truth is more wonderful and of more social service than charlatanism, and that truth welcomes investigation.

UNKNOWN RIVERS ARE EXPLORED BY SCIENTIFIC EXPEDITIONS.

THE MAIN FUNCTIONS OF ALL MUSEUMS

All knowledge is the result of research, so that research is one of the most important services to education that a museum can accomplish. The little child is a true scientist. By tasting everything he learns what is poison; by feeling fire he learns that it burns. After knowledge is thus obtained by investigation, it may be taught to all by such means as scientific reports, exhibits, lectures, encyclopedia text-books, popular guide books, magazines and newspapers, either in or out of schools, libraries and museums. No one knows who discovered how to make fire, but we learn how rather than discover how. So the older child in school loses much of his scientific method and depends more on memorizing the discoveries of others.

The research of the past produced the knowledge we learn and use to-day, but research is still going on. So all museum teaching work is based upon research. Some museums are

SCIENTIFIC WORK IS DONE IN DISTANT PLACES BY SCIENTISTS SENT OUT BY SCIENTIFIC MUSEUMS.

limited to research work and in museums recreation may be derived from seeing and learning of natural and beautiful objects.

MANY KINDS OF MUSEUMS

We have possibilities of many kinds of museums, such as scientific or research museums, university museums, school museums, children's museums, kindergarten museums, public museums, recreation, tourist or vacation museums, farmers' museums, commercial museums, museums of safety devices, museums for the blind, and art museums, while zoological and botanical gardens are kindred institutions—living or out-of-door museums. We have museums dealing with specimens from the whole world, others able only to deal well with specimens from one country, province, county or local area. Also there are national museums supported by nations, museums supported by provinces, cities and societies.

Scientific or Research Museums

Museums devoted solely to scientific work send out exploring expeditions, store specimens to be used for research, carry on scientific investigations, and publish the results. To get some scientific material by means of which new knowledge is found out and by means of which this knowledge is diffused to all the world, hardy men must penetrate into the uttermost wilds of the earth, endure the bitter cold of the Arctic and the dangers of the tropical forest. In the past some scientific museums degenerated into dusty garbage heaps, and research work was neglected in a stampede for "popularization" which was not even interpretation.

University Museums

University museums give opportunity for professors and students to do scientific research work and supply labeled specimens, casts, models and maps to illustrate the courses of study, just as the university library supplies literature.

School Museums

School museums not only teach by exhibiting labeled specimens that illustrate the subjects in the text-books, such as lava mentioned in the geography, and cotton bolls mentioned in botany; but they also give each student a chance to do research work, or to observe, draw conclusions and think for himself, rather than merely to memorize what his teacher tells him or what is in some text-book. Thus early in life he may have actual practise and become proficient in what he needs to do all through life.

Children's Museums

Children's museums are similar to school museums, but are not so intimately connected with school studies and are of more general interest. They usually maintain many lecture courses illustrated with beautiful lantern pictures. Museums have so interested children in this method of study that they have to exclude children during school hours to keep them from running away from school.

Kindergarten Museums

Kindergarten museums are, as might be supposed, children's museums of very elementary character. Some other museums provide a trained kindergartner to assist children in

SCIENTIFIC MUSEUMS STORE SPECIMENS TO BE USED FOR RESEARCH.
Herbarium in the Geological Survey Museum.

studying specimens. Others have so many children visitors as to require a staff of kindergartners.

PUBLIC MUSEUMS

Public museums, as the name indicates, are of material so arranged as to interest the general public rather than the scientist or the school child. They aim to provide recreation. It is now understood that education does not cease at graduation, but continues throughout life, and so exhibits of an educational character are provided that are of broad, world-wide, general interest to adults as well as to children and scientists. In other words, they are like school museums adapted to older people. Then, too, it is known that to learn of beautiful and interesting things outside of the day's work is recreation, and, conversely, that recreation may attract the people to exhibits and that, once attracted, they may be taught much that will be useful to them.

RECREATION, TOURIST OR VACATION MUSEUMS

Recreation or tourist museums aim to give recreation and to rest tired minds by directing attention in new channels and are

usually devoted to the area where they are located as supplementary to the out-door tourist attractions.

Farmers' Museums

Farmers' museums are not yet well evolved. Possibly they will use specimens of various kinds of soil, with labels telling what crops will grow best therein. They may need samples of seeds. I have known of a farmer disgusted with his crop of seed because he had never before seen just that kind of seed in its hull and thought it was shrivelled when in reality it was excellent. Farmers' museums will probably have specimens of the eggs, the young in various stages and the adults of the chief insects which do damage to crops and with specimens showing the damage which they do to crops, together with labels telling how to get rid of such pests. The labels may tell the great total money value of the annual loss to the crops. If the museum can not afford specimens of each breed, sex and age of cattle, horses, sheep, poultry and the like, it may at least have good pictures with labels indicating the points of excellence to be arrived at in breeding. There may also be exhibits of the bones of the domestic animals with perhaps pictures of diseased conditions, and labels telling how to cure them.

Vast Numbers of Publications are issued by Scientific Museums. The Geological Survey Museum, Canada, sends a copy of each publication to every Canadian library and newspaper and to many Canadians. It also sends to many institutions and persons in other countries, and still has a reserve stock for future use.

Commercial Museums

Commercial museums show resources, industries and commercial products and are chiefly maintained by and for business men. In one, for instance, are shown boats, nets and the whole salmon industry, from the salmon to the can, or coal, with models of mines and pictures, so that if a coal man's visiting friend had insufficient time to visit the mine, he could get a good idea of it in town. Such museums appeal to business men chiefly because they advertise their wares.

Scientific Research is carried on in Scientific Museums.

Art Museums

Art museums of the past all too frequently exhibited a few old masters and broken sculptures, while the art curator sat like an owl clothed in unapproachable dignity. Now the best of them encourage beautiful handicrafts among the humbler workers, and take an interest in beautifying the place where they are located, as by advising on town planning, on the archi-

tecture of public buildings and bridges, on the laying-out of public and private gardens, on the mural decoration of such places as schools and theaters and on the artistic furnishing of houses. The great artists who painted the old masters and modelled the now highly prized though broken sculptures of antiquity no doubt also did much more to beautify their cities and assist their citizens to live beautiful lives than is indicated by the broken bits of statuary dug up and shown in museums. They probably had fine gardens themselves and worked for civic improvement in all esthetic lines.

A National Museum

A national museum might include several kinds of museums or all kinds; certainly it is better able to do scientific work, special work, and cover vast areas than museums which have less financial backing and which are unable to send expeditions to far countries or to employ highly paid specialists. A national museum may present samples of all kinds of museums as patterns to the other museums of the country. A city wishing to establish a children's museum, for instance, may first study the children's museum hall in a national museum.

Aimless museums are evolving into institutions of definite and useful purposes. It is now known that each should do the work it was founded to do and is supported to accomplish, that a scientific museum is out of place in a town that is not a scientific center, a university museum is appropriate only in a university, a commercial museum is wasted except in a great mart, and a farmers' museum is not the most suitable kind for the city slum. An up-to-date museum in a small town with insufficient funds no longer tries to do what the British Museum in a large town financed by a nation does. A real scientific museum is no longer a hodge podge of a kindergarten museum and a commercial museum. A university museum now plans to differ from a museum solely devoted to scientific research and from a school museum. A museum for the general public is now known to serve the people poorly if it is labeled like a scientific museum, so that its labels do not interpret science—that is truth—to the general public in the language of the public. A farmers' museum probably has insufficient funds to devote energy to anything except the farmers' interests.

Museum Buildings

Museum buildings were built as architectural triumphs, but now more attention is given to building them so they will serve

MUSEUM KINDERGARTNER AND CHILDREN IN THE AMERICAN MUSEUM OF NATURAL HISTORY.

museum purposes. Some museums no longer wait for a fireproof or permanent or larger building, as that is certainly a waste of time. I once knew of a professor who complained that he could not teach a number of interested students because he had no class room, but I believe I can recall hearing of certain great teachers of antiquity, who taught their disciples by the roadside, without either class room or place to lay their heads, and this idea also applies to museums, for, after all, the whole outdoors is the best museum. A corner in every school-house may be a museum; a nook in every board-of-trade building may serve the same purpose. Much may be learned in a cheap inflammable building, and so in it may be made a more useful museum than are some poorly managed museums possessing fireproof structures costing thousands of dollars.

Sources of Museum Material

The inexpensive bee from home may be as interesting and useful or more interesting and more useful than the expensive orang-outang from afar. There is enough material near a museum for all the collections it has room to house. The fish and shell fish of the river, the frogs of its banks, the insects and plants of the door yard, the birds in the trees, the animals near by, the minerals, rocks and fossils of the hills, all offer useful material for research, education and recreation. Few people can answer the simplest questions about these things and more such specimens can be collected in an hour than can be labeled with encyclopedic labels in a year, to say nothing of properly preparing and preserving them. Some museums have many friends; for instance, for years the Barnum and Bailey Circus had all its rare animals which died on the road preserved and sent to a museum.

Exhibits

A hall of museum exhibits is often like a great book, an encyclopedia, where each description is illustrated with a real object. A library has books containing descriptions sometimes illustrated with pictures, maybe even colored pictures, but a museum has the actual object to illustrate its descriptive label. In the early stages of museum evolution, birds and animals were stuffed for exhibition and often the animals looked like bags with four legs. Now such exhibits are made by artists. Instead of stuffing a skin a sculptor models the form of the animal as if it were alive, but with its skin removed. Then

A Recreation and Tourist or Vacation Museum. The Rocky Mountains Park Museum at Banff, in the Canadian Rockies.

the skin is placed over this form, which brings out the real anatomy of the animal. Even exhibits to illustrate man are made in a similar way. Plaster casts are made of various native tribes. These are posed as engaged in the typical activities, colored to resemble the living people, dressed in the proper costumes, and placed among the natural surroundings in front of a painting made by an expert artist, to illustrate the home country. This work can not be done by untrained men, but must be accomplished by artisans, mechanics and artists who have had very special training each in his own particular line. Sometimes in a country of millions of inhabitants there is no man trained in a certain special kind of work, so that a museum often has to send across the sea or to some equally far-away place for a skilled mechanic. Even Japanese, Eskimos and Indians are employed in one of our largest museums.

Some exhibits are made especially to be pedagogic, as, for instance, to show the life of a moth from egg to adult. Such exhibits are visited by school teachers with their classes.

Sometimes models teach quite as much as actual specimens. A model of a mosquito made many times larger than the insect itself shows us how to cope with malarial fever and yellow fever. We could not see the means by which the mosquito transmitted these diseases by looking at the mosquito herself,

but the scientist in his laboratory with his microscope may find out all these things, make accurate plans and drawings of the various parts of the insect, and leave it to skilled mechanics to spend many months in reproducing them accurately on a large scale. Such work is not an extravagance when we consider that if the doctors and the people learn to avoid yellow fever and malaria the life-insurance companies do not have to pay so much life insurance and the amount paid for one death is easily sufficient for the construction of such a model.

Pictures are very useful with exhibits. For instance, bones of extinct animals are frequently found. No one knows what these animals looked like in life, but the scientist can study the bones and compare them with the bones of animals which he is able to observe. His artist can paint these living animals and he can explain to him in what respect the bones of the extinct animal differ. By a study of the bones of the feet he may learn and explain to the artist whether the animal walked in a swamp or on rocky ground. By a study of the animal's teeth he may tell what kind of food it ate. Then the artist can make his picture very much more intelligently than otherwise would be the case, and this picture conveys to the people some idea of what the animal formerly looked like. Sometimes the artist makes a sculpture of the animal instead of a painting or to accompany the painting, so that a complete exhibit might show a skeleton with a painting, a model, a label, a map, and perhaps even another animal, such as lives to-day and is akin to the extinct animal.

FROM RIVER BOTTOM TO MOUNTAIN TOP NEAR THE ROCKY MOUNTAINS PARK MUSEUM IN THE CANADIAN ROCKIES ENOUGH SPECIMENS MAY BE COLLECTED TO FILL THE ENTIRE MUSEUM.

INEXPENSIVE TREE EXHIBIT, made as a by product of less than a day's work. Rocky Mountains Park Museum.

Specimens are arranged together for such purposes as to illustrate the idea of evolution, to show all the different musical instruments of the world, or to show all the things found in a certain province or all the animals, plants, minerals, and so forth, of a certain region, as, for instance, a desert, and contrast them with things from a forest.

Scientific books, that have been based on specimens and illustrated by pictures of the specimens, are often placed near the exhibits of the specimens, as are also guide books, especially written for the public, that is, giving the main scientific facts translated into the language of the people, but omitting details of interest only to the scientist or as matters of record.

Some museums make a special effort to prepare timely and useful exhibits and place them most conspicuously. These are sometimes hastily made to meet an impending demand for knowledge. In 1912 the tent caterpillars were so numerous in the vicinity of Ottawa that they destroyed the leaves of many shade and ornamental trees in the city and many fruit trees

on the farms, as well as forest trees. They were even so numerous that their presence on the tracks delayed railroad trains many hours. The number of eggs on the trees in the spring of 1913 showed that this damage would be repeated, so an exhibit was prepared for the benefit of the people. One side of the case shows the life history of the tent caterpillar and some of the trees which it attacks. On the opposite side of the case are shown some of the means of controlling this pest. There are birds, photographs, lumps of chemicals, and a pail of commercial tanglefoot—an exhibit of inexpensive things that may save a city's shade trees—as useful an exhibit as one of rare objects. Magnifying glasses are used as an adjunct to this exhibit so that some of the smaller specimens may be more easily seen. When pressing need for such an exhibit is past, it may be retired or put in a less conspicuous place. This is an example of how officers of museums are endeavoring to find out what is useful to the people and to prepare helpful exhibits.

BUFFALO SPECIMENS GROUPED BY LOCAL LABOR AND CASE BUILT BY LOCAL CARPENTER IN ROCKY MOUNTAINS PARK MUSEUM. Such a case can be made for ten dollars wherever window sashes are available.

CASE WITH SASH REMOVED IN ROCKY MOUNTAINS PARK MUSEUM. Such a case can be made wherever window sash can be had. This ten dollar case is as useful for teaching purposes as five or six hundred dollar cases of some museums.

EXAMPLE OF USE OF STAFF

Officers of a museum have sometimes served the public on commissions or in other ways outside of the institution. For example, one zoologist was a member of the international commission which arbitrated the seal question.

LABELS

A museum of specimens of things of which we should

EXAMPLE OF USE OF EXHIBITS

An example of the use of a museum exhibit is illustrated by a page of designs taken from an exhibit of Indian handiwork. This page was distributed by an art teacher among all his students in the public schools in his work to better the designs of furniture, wall paper, stoves, etc.

POLICE AND FIRE PROTECTION IS GIVEN SPECIMENS IN MUSEUMS. Museum of the Geological Survey, Canada.

know, rather than of things merely curious or from so far that they do not affect us, if labeled and accompanied with models, maps and pictures, may easily be of more social service than some existing museum costing say ten times as much. In order to give this information clearly large classifying signs, smaller signs and still smaller descriptive labels are used and are as important as specimens. Besides these there are labels for each specimen chiefly to tell where that particular specimen is from and what it is. A collection of labels without any specimens might be of more service in a museum than a collection of specimens without labels. Labels asking questions may be used in a school museum to cause the visitor to observe closely and find out things for himself.

Publications are issued by various kinds of museums for as many purposes as the museums serve, such as records of research, complete catalogues giving details, popular guides calling attention briefly to the chief things of interest, and journals to interest people in museum work. Guide-books sometimes illustrate more than half the specimens exhibited, so the visitor from a thousand miles away may carry to his friends at home a glimpse of a large part of the exhibit with a full description and even with reference to authorities, for their use in case they care to pursue the subject into original sources. Some museums give such guide-books to the public, but as certain classes of people throw them away or destroy them, other museums prefer to charge a small sum for guides. This charge is usually less than the cost of the book.

Many museums now invite the people, through the public press, to avail themselves of its advantages. Often people would not know what they are missing, as of recently acquired material, and scientific news, were these not advertised in the papers. Business has found advertising to pay and museums now appreciate that it does. The citizens pay the taxes which make the scientific work of some museums possible and the staff feel in honor bound to lay aside their research for a time in order to explain in non-technical language such results of their study as may be valuable or merely interesting to the public.

Publishers are encouraged to make postcards of museum exhibits and in this way through the natural channels of trade information is spread far and wide without any expense to the museum.

LIBRARY

Libraries constitute part of the equipment of many museums and suggest a tie between museums and other educational insti-

tutions. The books are used by both staff and visitor. The staff always needs to inform itself in order to do its work of research, preparing, installing and labeling.

VISITORS

Different classes of visitors use museums, rich and poor, wise and ignorant. Carpenters often study the specimens of woods, miners the minerals, teachers of art and architecture the collections of primitive art and the objects and pictures, showing the types of building of other times and other peoples.

PAINTING BACKGROUND FOR THE LOBSTER GROUP IN THE GEOLOGICAL SURVEY MUSEUM, CANADA.
This work can be done by untrained men.

Normal school classes that study in museums scatter what they learn from the exhibits to school children as far and wide as the region their normal school represents.

On the occasion of an exhibit for the prevention and cure of tuberculosis in one museum, over forty thousand visitors passed between the police lines in and out of the exhibit in a single day, which proves conclusively that the public is thoroughly alive to the importance and value of the most modern and useful museum work.

Lectures and Photographs

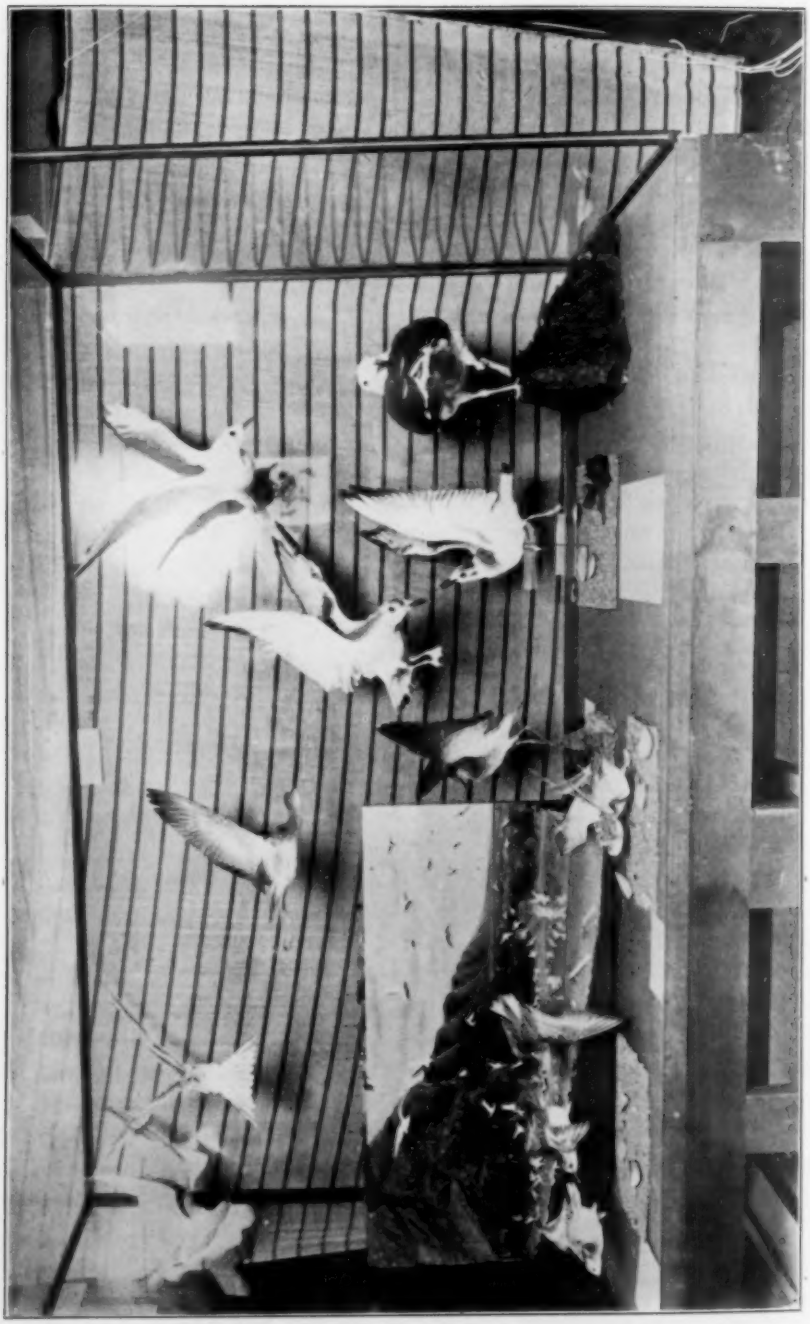
Lecture halls are included in the equipment of many modern museums. One museum has three lecture halls and gives lectures every day. Each lecture is made as appropriate to the audience as possible. So there are simple lectures for children, general lectures for the public, and specialized lectures for scientists, or people interested in the details of a single subject. There are also lectures for teachers, and for those who wish general entertainment in the lines of museum work. Even short informal talks, sometimes illustrated by specimens, are given when desired in exhibition halls, offices and shops.

The lectures are usually illustrated with specimens or lantern views, in some cases thrown up over thirty feet square and unsurpassed in coloring. Even the moving picture is used. Some museums collect vast numbers of negatives, some of them taken on expeditions, which form a great historic archive of increasing value as time passes. Prints are used for illustrating scientific papers, encyclopedias, text-books, popular books, magazines, newspapers, and the like, and from them are made hundreds of sets of lantern slides for illustrating as many lectures. One made over seventy duplicate sets of slides of each lecture, and sent them throughout a whole state for the use of all the teachers. It specified that no admission should be charged. Large audiences attend museum lectures. Seven thousand children once tried to hear a single lecture in a museum hall holding only 1,400, but eleven extra lecturers were called by 'phone from the door, the children were deflected to twelve different halls and were interested and instructed.

The photographs made from negatives taken on expeditions are kept in files or in scrap-books where they may be consulted, and prints are given out in small numbers free of cost, or in large quantities for the actual cost of the photographs, without regard to the expense of the expedition necessary to secure them. These are given to scientists for study and for illustrating their books, to educators to use as illustrations and to hold up before their classes. Many of them are used by magazine writers and newspaper men for illustrations and by sculptors and painters. In this way the explorer brings back glimpses of far-away lands which eventually are shared with people unable to travel or who must travel nearer home.

Loan Exhibits and Meeting Places

Some museums loan space for special and temporary exhibits such as art loans, flower shows, and sanitary exhibits,



SPECIMENS ARE NOW MOUNTED ACCORDING TO A MODEL JUST AS A HOUSE IS BUILT ACCORDING TO AN ARCHITECT'S PLANS AND SPECIFICATIONS.
Geological Survey Museum, Canada.

of which one illustrated the fight against the great white plague. For a few hours or days such exhibits are placed in front of the permanent museum exhibits.

Museums also become social centers or headquarters for scientific and educational purposes, where any or all classes of people may learn of or enjoy such things as art and science. The large lecture halls are particularly appropriate for general meetings and the smaller rooms for special societies.

Traveling Exhibits

Where a few specimens are needed by thousands it is easier to move the specimens than the people. Branch banks, university extension lectures and traveling libraries grew out of a similar cause. Exhibits are put up in carrying cases with labels and guide-books describing the specimens, and these are sent from school to school, to libraries and other suitable places. In St. Louis, Chicago and New York, for instance, the success of this work has necessitated the use of museum automobile delivery vans and many thousands of children are served.

The business men of Canada for several years sent a train known as the "Made in Canada Special" throughout the length and breadth of the country. This train contained exhibits of the manufactures of the Dominion. It was a commercial museum on wheels, and it stopped only a few hours in the places visited, but it was thronged with visitors anxious to learn of the manufactured products of the country. Agricultural colleges and railroads have been using a somewhat similar method to uplift the people, and, if business men find it worth their while to educate the citizens, it would seem to be the duty of educators to consider this method for museum extension. Useful exhibits and moving-picture lectures installed on railroad cars side-tracked at various places would not only carry art, science and other phases of social service to places where no museum exists, but also present a model of methods to museums.

Museum Cooperation

There are over sixty museums in Canada, counting large and small. They are found from coast to coast, but are most numerous in the older settled and most cultured parts. Specimens are often loaned or given to smaller museums by the larger ones. Encyclopedic labels may be more economically produced if written by one curator, criticized by several, and printed for all. This saves the expensive duplication of writ-

SAND HILL CRANE GROUP WITH HOME SURROUNDINGS AND PAINTED BACKGROUND IN AMERICAN MUSEUM OF NATURAL HISTORY.

ing and typesetting and has the advantage that the labels are more accurate than if the work of one man working without criticism. Some such labels have been prepared by the Dominion government and offered free of charge to all the museums of the Dominion. At least eighteen museums and one zoological garden have taken advantage of this cooperation. A national museum may thus become a clearing house for all the museums of a country.

Conclusion

A finished museum would be a dead museum, but there is no such thing as a finished museum, for scientists are always making new discoveries which lead them to add new things, and to rearrange or re-label old material.

The museum that really teaches the children of to-day, and otherwise becomes useful to the public with clean though cheap cases, will gain the sound financial support which it deserves, at least as soon as the children of the present generation grow to positions of authority. The museums certainly have a great opportunity to be open on Sunday and at hours when those who work and all those who wish can make use of them. They may cheer, educate and uplift the humbler workers and the slum dwellers. These are the people, who, unable to travel, or perhaps even to buy books and pictures, may need the services of museums and kindred institutions more than those who have wealth and leisure or any other class. Museums may compete with ignorance and vice by pointing the way to the appreciation or use of things now neglected or unknown, and to greater joys and healthfulness through beauty and knowledge, until there is no room left in the mind for vice. Schools and universities had to struggle for recognition. Only a few years ago some communities looked upon libraries as of little or no importance, but now prize them highly. Museums come next in this evolution. Museum men may not know yet just how to perfect museum work, but if all carry on experiments and evolve useful methods as rapidly as some have during the past twenty years we may expect that within the next twenty years we shall have some museums at least that will be considered as useful as our best schools and libraries.

MINERAL RESOURCES IN WAR AND THEIR BEARING ON PREPAREDNESS

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I

THE raw materials of war are men and minerals. The one stands in immediate contact with the enemy; the other lies back of the organization that supplies the munitions of war. The first has always been recognized as of prime importance; the second has been forced into prominence only by the unprecedented conditions of the European contest. But even now attention is too exclusively focused on the *industrial* aspects of the problem of preparedness, and too little care has been devoted to the ultimate sources of the materials of war, to a study of mineral resources from a military standpoint.

War has changed from an art to a science. It has come to be a large-scale engineering operation—a conflict of vast quantities of materials, handled by skilled labor, directed by expert knowledge. It is now a matter fundamentally of applied physics, chemistry and geology.

A result of the development of war along material lines has been the tendency to reduce the men on the battlefield to a dead level of equality. The bravest or the most numerous army no longer wins; the victor is the army best equipped, the one with the best home organization back of it—ultimately the troops of the country that commands the largest supply of coal, iron and fertile soil. The present war, indeed, has been termed by various writers "a war of coal and iron," "a war of metals," and the like.

The manufacture of most of the munitions of war, and of actually every implement of fighting, depends upon some mineral resource. Guns, projectiles and armor plate demand iron, copper, zinc, lead, antimony, manganese, nickel, chromium, tungsten, molybdenum; not one, or several, but all. The lack of a critical steel-hardening metal, though used in small quantities only, would render the most extensive iron deposits void for military purposes. This England discovered to her discomfort at the beginning of the War; to her disaster, had com-

mand of the seas not been hers. Explosives require nitrogen, sulphur, carbon, aluminum, and certain organic products obtained from the destructive distillation of coal. The railway, the ocean vessel, the motor truck, the aircraft, all depend upon coal or oil and many metals. Without copper and platinum, the telephone and wireless would remain silent. Even the surgeon draws many of his most essential drugs from coal-tar derivatives; while food and clothing, without which all other supplies would avail nothing, are direct or indirect products of the soil, for the quickened production of which potash, phosphates and nitrates must be available in abundance.

And not only must an army be munitioned, it must also be financed; and here a complexity of factors enters, not the least of which is the activity of the mining industry in general and of the supply and output of gold in particular. The fact that at the outbreak of the European war the British Empire had long been producing about three fifths of the world's gold, while the Central Powers were contributing less than 1 per cent., introduced an economic condition whose significance would have been more apparent had circumstances been reversed and Germany, and not the Entente, been the great purchaser of supplies on the American market. The Central Powers could better afford to be without great reserves of ready gold than their enemies.

In a table of the eighty chemical elements composing the universe, I have just counted thirty that are required in modern warfare. Lacking these, or the ability to obtain them, no nation can stand by virtue of superiority in either numbers or quality of men. The want of even a single essential may prove disastrous.

Countries rich in developed resources, therefore, are much better prepared for war than those whose mineral resources are scant or imperfectly developed. In fact, no country can become a great world power without extensive and varied mineral wealth. The British Empire, the German Empire, and the United States have achieved this end; the Russian Empire, China, and a confederation of South American republics, to include at least Brazil, Chile, and Bolivia, have this possibility. Argentina is the most exclusively agricultural country in the world, yet it is certain that she could not obtain a dominant position on that alone; for such an accomplishment, alliances with neighbors rich in minerals would be essential. An embargo on coal shipments from the United States under present circumstances would seriously embarrass, if not disrupt, her economic life.

Germany could not have maintained her stand in the present war had her territory been poor in variety of minerals or had not her chemical skill risen to fill gaps in her natural products. Of essential minerals, she has probably felt a serious stringency only in copper, nickel, aluminum, tin, antimony, manganese, petroleum, and nitrogen; but her chain of strength was kept from breaking at these weaker points by accelerated metallurgical and chemical developments, the extension of mining to low-grade deposits, heavy importations at the outset from Norway and Sweden, and probably also by anticipation and storage of these very products in large quantities in advance of hostilities. Her supply of iron would have proved inadequate if the events of 1871 had not placed in her hands the great iron-ore fields of Lorraine, which more than doubled her reserves of this metal—an advantage not generally appreciated at the time, as a suitable process was then lacking for working these low-grade ores. But their significance became apparent enough in 1914 when the German line embraced the extension of these fields lying in French territory east of Verdun and the French iron industry was thereby deprived at a single stroke of over 85 per cent. of its supply of ore, which was soon diverted into German blast-furnaces. It is surely the irony of fate that Germany to-day is practically waging the war with iron drawn from territory formerly French and worked into steel by a process devised by two Englishmen!

England has abundant iron and coal, but is deficient in most other mineral products of military significance. France is a manufacturing nation with few mineral resources, and of these her most important, the coal and iron fields adjoining Belgium and the German frontier, were captured early in the War. Russia (including Siberia) is a country rich in variety and quantity of minerals, but not only are these resources for the most part undeveloped, but their very distribution and extent are imperfectly known. In consequence, Russia has more men than she can adequately arm and munition. Industrial organization for war is one problem and can be quickly arranged for—behold England; the development of a country's resources is a different matter and can not be accomplished in a brief period of years—that Russia has learned to her loss. Therefore, it has devolved upon the British navy to maintain the command of the seas, not only that England herself might be provisioned, but that her allies might be supplied with the raw materials of war which their own territories alone were unable to furnish.

Looking further, we see in China a region of vast extent with a mineral wealth almost wholly undeveloped, to a large extent unknown, yet shown by successive explorations to be of great potentialities. For this and other obvious reasons, China is unprepared for a struggle with even a third-rate power; yet she has the raw materials of a world power. It is not unreasonable to suppose that Japan, herself rapidly developing to the limit of her restricted territory and resources, is seeking new fields for expansion; she has doubtless many times had visions of what an organized China might be; certainly those who would impute to her ambition designs against the distant shores of California, forget that at her very door lies a country probably nearly as rich in a material way as America ever was. China developed, we may have Japan to reckon with; as it is, the resources of China must appeal to Nippon as more alluring than the vague idea of a Japanese state in North America.

II

Not only is war to-day directly dependent upon mineral resources, but the development of the art of war through the ages has followed rather closely the advancing exploitation of mineral deposits. Stages in the upward progress of primitive man indeed are actually marked by the implements used by him in the chase and in war, according as these were of rough stone, of polished stone, of bronze or of iron. Lucretius, the Roman poet, recognized this fact two thousand years ago when he wrote:

> Weapons of old were hands, nails, and teeth, and stones, and boughs broken off trees, and flaming fire, as soon as it had become known. Afterwards the use of iron and copper was discovered, but the use of copper was earlier than that of iron; for it is easier to work and is found in greater quantity.

The accounts of the earliest wars bristle with spears, javelins, helmets, arrows, and catapults—all products, in part at least, of mines and quarries. The stirring lines of Homer resound with the clash of arms, and every school-boy knows the trappings and implements used by Cæsar in pressing his Gallic Wars. Ancient warfare was dependent upon stone, iron, bronze (copper and tin), and oil.

The two greatest inventions of the Middle Ages were printing and gunpowder. But the printing press is not our theme, however much it is dependent on lead and antimony or is now gorging itself on the details of modern fighting. When a German monk by the name of Schwartz (although there are some

who would claim the honor for Roger Bacon) ground up a mixture of charcoal, sulphur and saltpeter, in the seclusion of a fourteenth century cloister, he loosened a force that was destined to shake the ages. The contribution of this early Teuton militarist altered the whole course of war; seized upon by the forward sweep of western thought, the principle of violent disruption was not allowed to sink beneath the lethargy of inaction, as had happened ages before in China. Soon the arquebus replaced the spear, and Mars himself, like the American Indian a little later, must have been surprised at this new and fearful "speaking death."

It is not necessary here to trace the development of the implements of war from medieval to modern times. The very names of blunderbuss, matchlock, muzzle-loader; of battle-axe, rapier, cutlass, saber; or of pike, lance, bayonet will call up vivid pictures of successive stages; while the appliances used in recent years are too familiar to need recounting. From the sixteenth to the middle of the nineteenth century, chemical elements of principal military note were iron, lead, carbon, sulphur and nitrogen.

Of these, nitrogen was critical. The available supply of this element was limited, in spite of its abundance in the atmosphere. It could be obtained only from sporadic deposits in caves, from the surface of some soils in semi-arid regions, and from accumulations of refuse matter—all undependable in time of need. A plan was later developed for inoculating the soil with colonies of nitrifying bacteria, and for a period niter plantations were common industries in Europe, and even in this country at the time of the Civil War.

But any widespread manufacture of explosives was impossible until the discovery in 1821 that the desert of Tarapacá near the west coast of South America was underlain by a blanket of sodium nitrate gave to the world an unexampled source of the elusive constituent. The development of these nitrate fields in the most unmitigated desert in the world, against serious political and climatic obstacles, advanced the arts of peace no less than those of war and rendered possible the developments in mining and transportation that have characterized the last half-century. The total effect upon civilization of this mineral occurrence, which a single rainy season would wash away, can scarcely be estimated.

It is now clearly recognized that the Chilean deposits will not last always, nor could they be relied upon by a country in periods of effective blockade. These are facts which have stim-

ulated the development of the by-product coke oven, which yields nitrogenous compounds on the distillation of coal, and of several processes for separating nitrogen from the atmosphere and fixing it in usable form—advances that have been carried further in Germany than elsewhere, much to the advantage of that country in the present struggle.

III

As economic factors in shaping history, mineral resources have played an important rôle. In particular they have been a direct or contributing cause of many wars. The war between Peru and Chile in 1879–82 and the Boer War form two notable examples.

The Peruvian-Chilean war grew directly out of the development by Chilean interests of the nitrate fields, which extended from northern Chile across what was formerly a part of Bolivia into Peru. The conditions were ideal for trouble—a valuable mineral deposit, exploitation by foreign capital, unstable government, excitable temperaments. The result: Chile has now a monopoly on sodium nitrate, Bolivia is without seacoast, and Peru is minus her rich province of Tarapacá. The acquisition has made Chile the most prosperous country in South America, save one; her royalties from these fields sum up to hundreds of millions of dollars, and her very existence is bound up, as that of no other country, with the production of a single mineral deposit.

The Boer War was a by-product of gold mining in the Transvaal. The Rand district, discovered in the late eighties, drew the usual rush of gold-seekers, which met with disfavor on the part of the Boers. But the richest gold deposits the world has ever known had to produce, in spite of economic and political obstacles devised by Kruger and his government. The relations between the "foreigner," which meant the mining interests, and the Boers grew more and more strained; then came the Jameson Raid in 1896 and finally British intervention in 1899. Now the Rand mines are producing over $15,000,000 a month and aiding to finance the European struggle. Thus we have a literal illustration of the statement: "Gold the producer of War; War the consumer of Gold."

The desire for mineral wealth has always been a powerful motive in directing discovery and settlement. The Spanish Conquest in the two Americas forms a romantic example of men lured to great deeds by the lust for gold. The hope of finding the fabled "Land of El Dorado" was a very real incen-

tive to the adventurers who followed Cortes, Pizarro and Quesada on their wild and successful expeditions. In more recent time, the California gold rush of '49, the stampede to the Australian gold fields two years later, the discovery of diamonds in South Africa in 1869, and the Yukon fever of '98 are events which opened up continents and made empires of the waste places of the earth.

The Mexican situation to-day, at bottom, is rendered an international problem by the fact that foreign capital is exploiting the mineral wealth of a country—and Mexico's mineral wealth is great—in opposition to the wishes of many of its inhabitants.

Mineral resources play a rôle, if ofttimes an unspecified one, in the diplomatic relations between nations. A nation poor in mineral wealth tends to seek alliances with powers strong in the essentials lacking. The contest of European capital in developing backward or semi-civilized regions, the rivalry thereby entailed, and the desire on all sides to gain fields for future exploitation were factors of importance in shaping circumstances that led to the present European war. And we may be sure that the international rôle of mineral resources will assume greater importance in the future, when the stress of waning mineral reserves becomes more acutely felt.

IV

The intimate relation existing between war and mineral resources is shown nowhere better than in a plot of metal prices in the United States over the past three years. Under the stimulus of abnormal demand, munition metals have soared in value beyond all precedent, and a chart of their wild careening now looks more like an involved seismograph than a sober table of accurate facts. The different metals have responded differently to the war influence, showing an individual sensitiveness to the changed conditions in Europe; but in general the effect has been an immediate though somewhat small drop in price, followed by a sharp climb, in some cases to figures many times the normal, in turn succeeded by marked oscillations, but a general maintenance of a high-level average.

Pig iron, to consider the most fundamental metal first, held close to $15 a long ton during the first year of the war, but in July, 1915, began to climb slowly but surely until it reached a height of over $30 by the end of 1916. Copper, whose average price for thirty years preceding the war was almost 14 cents

a pound, and during 1912–13, 16 cents, dropped a little during the first few months of hostilities, but recovering early in 1915 reached 20 cents before the year was half over and ended 1916 above 31 cents. The career of zinc was even more spectacular; long used to a price that hovered around 5½ cents per pound, it responded with a few months to war conditions (the centers of the zinc industry abroad lay in Belgium and Germany), and during the first six months of 1915 jumped from 6 cents to 21 cents, only to fall back to 15 cents by December; in 1916, it experienced a sudden set-back upon the reorganization of the European zinc industry, sinking to 8 cents during the summer months and ending the year close to 11 cents. The war caught silver at 55 cents per ounce; its price thereupon slowly went down until April, 1916, when it abruptly advanced 10 cents, going to 74 cents in May and remaining near that figure through 1916. Antimony was formerly of limited use, but the war created a large demand, and "this being precipitated in an unprepared mining industry, the price rose by leaps and bounds"; originally 8 cents a pound, this metal commanded 42 cents at the beginning of 1916, and 46 cents in March of that year, but war-inspired production in China began then to be felt and it dropped to 14 cents by December. Aluminum entered the war at 17.6 cents a pound; 1916 saw its price average 60.7 cents. Other examples might be cited, but these are sufficient to show that the prices of the common metals in a peaceful country were increased fifty to several hundred per cent. because of demands put upon them by a foreign war.

These conditions have given an unparalleled impetus to mining throughout the world, and especially in the United States. The mining industry of this country is enjoying the wildest prosperity in its history; American mining companies that publish their dividends paid $170,000,000 in 1916, against $78,000,000 in 1915. New mines are being developed, old mines reworked, and many deposits are now producing which could not be operated under normal conditions. The return of former prices would spell disaster for many enterprises.

The zinc industry has been affected in a pecular and interesting manner. In 1913, of the world's supply of this metal, the United States produced one third, Germany one fourth, and Australia one fifth. Most of the foreign ores were smelted in Germany and Belgium, Australia's output from the famous Broken Hill mines going almost entirely to these two countries. Little zinc was smelted in England; the smelteries in France lay near the eastern frontier. The entire zinc industry of

Europe therefore passed into German hands; and the United States was called upon to supply the shortage of zinc among the Allies, who found themselves in the position (one which might have easily been foreseen) of having plenty of zinc ore, but no means of rendering it useful. The price of zinc soared; American zinc flourished as never before; the Australian mines faced disaster. Then the situation readjusted itself; smelters were built in England; electrothermic furnaces sprang up in Norway and Sweden; Japan, China, and Canada became producers; new markets, among them Japan, were found for the Australian ore. The price dropped; the stringency cleared up.

The Russian mineral industry felt keenly the effects of war, as it was wholly unprepared to get along without the markets of Germany and Austria, and as there were many gaps in its production which these countries had been relied upon to fill. Under the stress of circumstances, then, the Russian government did more for her mining industry in a few months than it had previously done in years: a systematic study of the mineral resources of the empire was undertaken; a corps of geological engineers was sent to carry on prospecting explorations in the Urals, the Caucasus, and Siberia; the land tax on gold fields was reduced; roads tapping mining regions were improved; and in general a lively interest was evinced in an eleventh-hour development of neglected mining opportunities.

France, deprived of her rich iron-ore fields near Verdun, was forced into quickened exploitation of lower-grade deposits in other parts of her territory; but the loss of her principal coal-fields could not be compensated and she is to-day suffering a serious shortage in fuel. China's mineral output has become a significant economic factor; while Japan is working overtime, experiencing somewhat the same era of prosperity that the United States has been enjoying. As to Germany, we may be sure that her mining industry, formerly highly efficient, has been the focus of much additional study, and that under the spur of necessity and beyond the influence of normal competition, mining operations have been extended to many low-grade deposits never before workable as ore.

The mining boom has of course stimulated those sciences that have to do with the treatment of the crude mineral products as they come from the mine—metallurgy, ore dressing, and industrial chemistry. The new and fairy-like "flotation method" of separating ore minerals from worthless rock by floating off the *heavy* particles by means of oily froths has in particular found this a favorable time for development; under

the balmy breezes of bonanza prices this infant has grown into a lusty youth of already notable achievements and even greater potentialities. Electric smelting, to cite merely one more example, has been forced past the experimental stage, and the past three years has witnessed the installation of more than one hundred electric furnaces, especially in Norway and Sweden, for the manufacture of steel alone, not to mention notable electrothermic developments along many other lines.

While the European War has sped up the production of gold, it has exerted a much greater effect upon the commercial movement of the metal. For the first time in history, this country has accumulated such enormous gold reserves that it has become not only the principal gold-holding nation of the world, but now has more gold than any other nation ever had. The world's supply of gold, exclusive of jewelry and works of art, is estimated at eight billion dollars, of which the United States now holds approximately three billions (2,700,000,000 on Nov. 1, 1916). Since December, 1914, the gold coming to this country has been equivalent to the production of the rest of the world during this period. In short, due to the war, the gold production of the world is finding its resting place in the United States. This situation is filled with grave concern for the future; its effect on the present, as a contributing factor to high prices, is obvious.

The impetus given the mining industry by the present war, however, can not be looked upon as an unmixed blessing. Apart from the destruction of mining activity in some sections, as in parts of Belgium, France and Roumania, and the serious setback given it in others, as in Australia, the economic loss involved in the total destruction of vast quantities of material, the existing supplies of which are limited, overbalances the financial gain and technical advance growing out of the war stimulation. The war has proved a serious drain on the mineral resources of the world in general and of the United States in particular, bringing the period of exhaustion of certain of these materials nearer. That, the people living in the fringe of depletion of such products will realize more vividly than we.

V

We have seen that war and mineral resources are intimately related; that mineral products are essential to the carrying on of war; that they have always been essential, but increasingly so; that they have, in certain instances, actually been the cause of war; and that in turn they are strongly affected by war

conditions. It remain now to consider briefly the situation of the United States as regards its mineral resources in event of continued war—an important phase of preparedness.

The mineral resources of the United States happily are extensive and varied. They are also well-developed. This country is not only the world's greatest producer of mineral wealth, but "possesses greater reserves of most of the essential minerals than any other nation." Moreover, thanks to the well-directed efforts of the United States Geological Survey, we know more about our mineral resources than does any other nation about its own, save perhaps Germany. The United States therefore is to-day better prepared as regards the *presence* of fundamental resources of war than is any other nation, better prepared in this respect, indeed, than she is from an industrial or human standpoint. But the problems connected with the exploitation and conservation of deposits now known, with the development of new and low-grade deposits, and the means for filling gaps in our present production are all peace problems that merely become more acute in time of war.

The value of the mineral production of the United States in 1913 was practically $2,500,000,000. In that year she produced about 40 per cent. of the world's coal, 65 per cent. of its petroleum, 40 per cent. of its iron ore, 55 per cent. of its copper, 30 per cent. of its lead and zinc; and of its silver and gold she yielded 32 per cent. and 19 per cent., respectively.

The coal fields of the United States are inland, scattered, and distant from frontiers. Less than 1 per cent. of their total tonnage has been mined; they will last, even under increasing consumption, for several centuries. The incredibly wasteful methods of coal mining characteristic of earlier decades have been considerably improved upon; the chief waste now is the loss of energy during combustion and the failure to utilize more extensively the volatile portion for the manufacture of gas, ammonia, and coal-tar products. Radical changes in the utilization of coal are bound to come.

The petroleum fields of this country are likewise scattered, but those of California, producing two fifths of the domestic supply, are close to the Pacific coast. The life of the petroleum reserves is variously estimated at between twenty-five and one hundred years. Terrific waste has taken place in this industry; much is still going on. The production will be prolonged somewhat by the development of a suitable process for distilling on a large scale extensive deposits of oil-shale occurring in the west and perhaps lower-grade deposits in the east. The ap-

proaching exhaustion of the oil fields is already being felt in the climbing price of gasoline. The adoption of an oil-burning navy will prove a tremendous drain on the oil reserves of this country, and the question obtrudes whether a successful maintenance of our present naval program will not demand the control of the large oil pools of Mexico.

Eighty per cent. of our iron comes from the Lake Superior region. Lacking these immense deposits, our iron industry would be seriously, though perhaps not fatally, crippled. The unmined iron-ore of present workable grade in the United States is estimated to represent an eighty-year supply at the present rate of consumption; but low-grade deposits are present which under future conditions may be forced to yield for seven or eight centuries.

Of important mineral products, there are seven of which this country has no domestic supply *developed* to the point of satisfying her war-time needs.[1] These are potash, nitrates, manganese, tin, nickel, platinum and pyrite.

Potash is of peculiar significance, for heretofore our entire supply has come from the famous mines of Stassfurt in Prussian Saxony, a locality which indeed has long held a monopoly on the world's output of this material, so indispensable to modern agriculture and to many chemical industries. The exactions of the German Potash Syndicate caused the United States a number of years ago to realize the importance of developing a domestic source of supply, and consequently the government instigated a systematic investigation, which, accelerated by the cessation of imports during the war, has met with some success. At present, in addition to a small recovery made from a number of waste products, including the smoke from Portland cement plants, a growing production comes from salt lakes in California and Nebraska and from deposits of a potash mineral known as alunite under operation in Utah; while certain deep and surface brines and the giant sea-weed of the Pacific coast, known as kelp, whose ash runs to 30 per cent. potash, are under development and giving promising results. In addition, there are extensive deposits of silicate rocks ranging from 5 per cent. to 9 per cent. potash, which would furnish an unlimited supply, should a suitable chemical process be developed on an economic basis for making the extraction, now too costly for practical results.

Nitrogen, the basis of practically all explosives, and like potash essential to chemical technology and to agriculture, is

[1] A stringency is felt in regard to a few other important minerals, but it would carry us too far afield to consider them here.

drawn largely from deposits of sodium nitrate in northern Chile. Unlike most mineral occurrences, this seems to be unique; no similar deposits of consequence are known elsewhere, and hence Chile has been able to maintain a world monopoly on this valuable salt. The United States alone imports yearly over twenty millions of dollars worth of this material, a little over one third of the total exports. While abundant in the atmosphere, nitrogen is so inept at chemical combination that a large supply of electrical energy is required to obtain it from this source, a serious disadvantage in America where water power is not fully developed and electric power is at a premium. Nitrogen, however, is an important constituent of coal, most coals carrying over one per cent. of this element. But this nitrogen is returned to the atmosphere when the coal is burned, and only when the coal is distilled or converted into coke in a modern type of oven known as the by-product or retort oven is this valuable constituent recovered in the form of ammonia, which may be changed by a process now becoming successful into the nitric acid required by the explosive industry. A ton of coal so treated yields $1.50 in ammonia, gas, and a tarry residue convertible into drugs, dyes, explosives, etc., while the heat-producing portion is left behind as coke, which may then be burned as fuel, or employed, as most of it is, in the iron blast-furnace. The United States in 1913, the last year unaffected by war conditions, produced from coal $8,000,000 worth of nitrogen products, but this figure would have been nearly $30,000,000 had the nitrogen been recovered from all the coal coked; and much greater had a higher percentage of the total coal mined been distilled before combustion. But in spite of these facts, Congress in 1916 appropriated $20,000,000 for the construction of a plant for obtaining nitrogen from the atmosphere, but made no provision for stimulating a more extensive recovery of this element from coal—a one-sided action inimical to proper progress as tending to discourage the by-product development. In other words, we are paying $20,000,000 to recapture from the air part of the $20,000,000 worth of nitrogen yearly sent into it by wasteful coking methods!

Manganese is essential to the manufacture of steel. No substitute is known for it. Although there are many low-grade deposits in the United States, this country in 1913 imported nearly 90 per cent. of its supply, getting part in the form of an iron-manganese alloy from England and Germany, and part in the form of manganese ores from Russia, India and Brazil. The war cut off practically all the foreign sources except Brazil

and of course stimulated the output of that country. But a shortage was created in the United States, which became acute; by April, 1916, the price was ten times the normal. The situation is now better, but a serious stringency is still being felt as the response of local ores is slow; were we suddenly isolated by the present war, "we should immediately need more time to bring the production of manganese up to our requirements than we should to create an army." In preparation for war, therefore, the problem of manganese is one of prime importance.

The United States is the greatest user of tin among all nations, her importation in 1913 being $46,900,000, about two fifths of the world's output. But she mines an insignificant quantity and that comes wholly from Alaska. Her supply is derived chiefly from Europe where ores from the Straits Settlements, from the island of Banca, off Sumatra, and from Bolivia come for smelting. Bolivia, with her increasing importance as a producer of tin ore, should be looked to as a direct source of crude material to be smelted here; and this has already been done to a limited extent. No adequate development of a domestic source of tin seems possible.

A small quantity of nickel is recovered in this country as a by-product in the electrolytic refining of copper, but there is no production from nickel ores, although nickel minerals are known at a number of localities. The world's nickel comes almost exclusively from Ontario, Canada and New Caledonia, most of the product of the former being shipped to the United States for refining before distribution and use.

Platinum, that rare and unique metal so essential to chemical research, is in strong demand throughout the world. In 1913 Russia produced about 93 per cent. of the world's supply, while the undeveloped deposits of Colombia contributed nearly 6 per cent., and the United States less than ½ per cent. The domestic production may be increased somewhat, but the more pressing problem is the conservation and proper use of the metal already in circulation.

The unusual shipping conditions arising out of the unrestricted submarine warfare have practically cut off the supply of pyrite from Spain, upon which the sulphuric acid manufacturers were largely dependent; a situation rendered serious by the large quantities of sulphuric acid required in the industries and for the preparation of phosphate fertilizer and explosives. The stringency is being tided over by the use of small reserves of pyrite on hand; and much attention is now being directed to the development of numerous low-grade pyrite and related de-

posits in the East, etc.; but the pyrite problem, while soluble, is not yet solved.

Preparedness is a complicated matter, involving the training of men, the organization of industry, the assembling of raw materials, and, behind, all the application of science to every phase of the problem. Preparedness, limited to the thesis of this essay, must *anticipate* the organized use of every mineral resource essential to war, which means practically every mineral resource. This involves study, investigation, exploration, organization, and conservation—rigorous, complete, scientific —which must be inspired and guided by the government. Much has already been done; much remains. And as mineral resources in the future will be more significant in determining the balance of power among nations than they are to-day, this problem becomes increasingly important at time goes on.

The writer hesitates, in conclusion, to make specific suggestions, as the manifold aspects of the problem can be adequately encompassed by no single individual. Yet he ventures to mention a few lines of activity, along which immediate action would yield a good return, whether peace comes soon or war continues. A detailed study of the mineral resources of the United States should be made from a military standpoint; the activities of the Geological Survey and the Bureau of Mines should be increased by enlarged governmental support; the topographic map of the United States as well as the geologic map should be pushed to completion; an adequate domestic supply of potash, nitrogen, manganese, pyrite and nickel should be rapidly developed, under governmental aid if necessary, and a thorough search instigated for tin and platinum; the War Department should engage a geologic staff; wastes should be eradicated from the mining industry by drastic means; conservation should be more thoroughly studied and more extensively applied, under governmental direction, in the light of military necessity; the antiquated mining laws of this country should be revised; a consistent plan of developing the public mineral lands, probably by a system of leasing, should be put into operation; governmental exploitation of public oil lands for military uses should be undertaken; the burning of crude oil and of uncoked coking coal should be strongly discouraged, if not actually legislated against; the further utilization of platinum for ornamental purposes should be heavily penalized; and finally the spirit of scientific research should be fostered in every way and be given its due place in the nation's life.

[1] This has recently been undertaken.

SCIENCE AND AN ORGANIZED CIVILIZATION[1]

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SO pervasively is science woven into the very fabric of western civilization that no appeal is necessary in behalf of extending its sway or enhancing its security. Everybody now recognizes that agriculture, manufacture, transportation, war, sanitation and medicine simply could not exist in the modern sense but for the objective sciences.

Urgent questions there certainly are as to particular ways of making the several sciences still more widely applicable, and still more effective for the interests mentioned.

But vast and noble as are these services of science, yet when science is regarded from this standpoint chiefly, it connotes technology rather than a mode of expression of the human intellect and will and hand *per se*. And we must recognize that, in so far as science is thus restricted, it is rather an instrument of civilization than somewhat of the real essence of civilization.

My part in to-day's program is to exhibit science as an interpreter of, and a participant in, the deepest life of civilization itself rather than as an instrument of civilization. But before proceeding to the task proper, I must shield myself with a few sentences against the possible inference that my attitude toward applied science is one of lukewarmness or even of deprecation. So remote from me are such feelings that I do not regard any science, however "pure," to have attained full worth and dignity until application to human welfare of some sort

[1] One of four addresses presented in a symposium upon "Coordination and Cooperation in Research and in Applications of Science," held during the meeting of the Pacific Division of the American Association for the Advancement of Science at Leland Stanford Junior University, April 5 to 7, 1917. The other addresses presented upon this occasion were:

"The National Research Council as an Agency of Cooperation," by Arthur A. Noyes, Director of Chemical Research, Throop College of Technology, Pasadena, California.

"Plans for Cooperation in Research among the Scientific Societies of the Pacific Coast," by J. C. Merriam, Professor of Paleontology, University of California, Berkeley.

"The Applications of Science," by William F. Durand, Professor of Mechanical Engineering, Leland Stanford Junior University, California.

has been found for it beyond the intellectual interest it may have to a few intense delvers in each particular specialty. The kernel of my view touching this matter is that all scientific investigation, no matter what may be done with the results after they are attained, must be pure in the sense that it must throb with devotion to the *pure truth* sought, otherwise it will be frail and misshapen, and timorous of the light of the common day. The publicly expressed policies and the accomplished work of the research institution for which I am in a measure responsible constitute, I venture to hope, evidence that my views on this matter are not entirely theoretic.

The initial contentions of the argument I present to-day are two: no federation or compact of nations can possess the elements of measurable permanency and usefulness the main roots of which do not reach clear through the layers of social custom, formulated law, and ordinary political organization and convention, and penetrate deep into the nature of man himself; and second, that such an understanding of man as this implies is the province of science, primarily. Biological anthropology, with special regard to its psychological aspect, is the only source of material for a proper foundation on which to erect a truly useful and durable international structure.

I am familiar with the opinion held by many jurists, statecraftsmen, publicists, teachers, ministers of religion and philosophers that they alone are the custodians of man's higher welfare, and that the occasional incursions of science into their provinces are more productive of harm than of good. Many who speak for these groups are particularly outspoken in the present distracted time against the effort to "drag biology into human affairs." Now we men of science must acknowledge fully and openly that this feeling toward science and toward us as students and apologists of science has much to justify it in certain ideas and undertakings of ours. The gigantic and rather easily won successes scored by many branches of science in these later decades have tended to make many scientists impatient, even scornful of that rigor and comprehensiveness of thinking which for centuries have characterized mathematics, formal logic and the main schools of western philosophy. Nor have the sciences, while winning for themselves institutional place and communal standing, kept themselves above that very same arrogance of learned caste for the overcoming of which at an earlier time science had to join combat with the old disciplines. Great and powerful, and at heart noble as is the science of our day, it yet is distinctly

poorer than it formerly was in that it has lost something of that manly boldness and the chivalry of its heroic periods.

But nothing is more patent once any one, whether humanist or scientist, tutors himself broadly and reflectively, than the fact that to maintain humanistic learning in complete and splendid detachment from scientific learning is no more possible than it is to maintain the dining-room of a household in complete detachment from the kitchen. The statesman who would exclude the biologist and the anthropologist from any voice in problems of government and social and industrial justice would be in like case with an orange producer who would exclude the botanist and horticulturist from a voice in the problems of good and abundant oranges. Oranges and oranges for dividends, the orchardist might argue, is what he is after, and men who busy themselves with such things as roots and wood and leaves and soil are too remote from his interests to figure in his calculations.

To all those who in our day proclaim the theory that science is really something apart from the deeper, the spiritual welfare of humanity, I call attention to a historical fact which appears very remarkable when viewed in the light of that theory. The fact referred to is that beyond question many of those writers on society, government and law who have spoken to us out of the earlier and intermediate centuries and who have influenced civilization most profoundly have avowedly taken nature and the nature of man as their starting point and constant base of reference.

I have recently given offence, I fear, to friends who are professionally occupied with the literature and philosophy of ancient Greece, by affirming that it is impossible for any one to understand Aristotle either in letter or spirit who does not know him as a naturalist—as a zoologist. Acquaintance with the "Parts of Animals" and the "Generation of Animals" and the "History of Animals" is, I insist, as indispensable to an understanding of the "Politics," the "Poetics" and the "Ethics" as is acquaintance with the Constitution of the United States to an understanding of our national and state governments.

And who that has dipped even his finger-tips into the learning and the thoughts with which Cicero enriched the world can have missed being impressed by his appeals to what, following the Greeks, he calls "the first natural impressions"? *De Finibus* is especially permeated with such pharases as "the principles of nature."

Probably no single author illustrates the point quite so vividly and dramatically as J. J. Rousseau. A recent commentator on Rousseau has expressed, in effect, the opinion that probably no other author whatever, modern or ancient, has put so powerful a ferment into social and governmental theory as Rousseau. And his own story of his life, as told in the Confessions, reveals even more clearly, if that is possible, than his formal treatises, the extent to which his exhortation "back to nature" was basic to his whole scheme. And of far more than historic interest for us in this country to-day is the fact that the entire sociological and political school of eighteenth-century Frenchmen of which Rousseau is, I believe, usually held to be the climactic figure, was first and foremost a nature-of-man school. This fact has, I say, more than a mere historic interest for us, in that our own national ideals and ideas send their roots directly back into that school, especially through Thomas Jefferson.

But the author to whom I find it advantageous to give a focal place in my discussion to-day is Hugo Grotius, the great Dutchman generally accepted as the father of international law. Few things seem to be more significant for us now than the circumstances under which his epochal book, "De Jure Belli ac Pacis," was composed, and his appeal to human nature in this work.

Listen to the full title of the book put into English: "The Rights of War and Peace, including the Law of Nature and of Nations." The Law of Nature and of Nations! Is there one in this audience who has read somewhat at length in the writings of the fathers of our nation to whom this phrase is unfamiliar? Whether the expression originated with Grotius or not I do not know, but certain it is that he made it his very own, and gave it a life and meaning that it had never had before. As one goes through the pages and chapters of his book, he becomes aware that an equally true title for it would be "The Law of Nature in its relation to War and Peace."

And what is the kernel of the whole matter? That the law of nations is essentially the same thing as the law of nature, and that the law of nature, especially as it expresses itself in the nature of man, is the supreme law of the universe, even the Divine Law not excepted. God Himself, Grotius points out repeatedly, is unable to set at naught the law of nature. Divinity, he naïvely reminds us, is incapable of making five out of twice two.

Reflect now on the circumstances under which the Rights of

War and Peace was produced. The work was written in the midst of the Thirty Years' War, and concerning the general situation the Honorable David J. Hill has said:

> Looking about him at the general havoc which war had made, the nations hostile, the faith of ages shattered, the passions of men destroying the commonwealths which nourished them, Grotius saw that Europe possessed but one common bond, one vestige of its former unity—*the human mind.* To this he made appeal and upon its deepest convictions he sought to plant the law of nations.

With this quotation another phase of our discussion is reached. The havoc of great war with its wreckage of former unities and of faiths affected Grotius as apparently it tends always to affect men. It left visible to him only one common bond among the peoples of Europe—"the human mind"—in Mr. Hill's language.

Even so with us to-day, the world cataclysm filling our eyes, our ears, our intellects and our hearts. Human nature stands before us almost stark naked. Hardly any of the former garments of political, social and industrial order hide its form. And so like Grotius we ought to scrutinize that naked body as under normal conditions it is hardly possible to scrutinize it.

And here comes a measure of uniqueness in my contention. Such a time of shattered custom and law as this is exactly one which reveals the need of, which gives the opportunity to, science. In former centuries, before great differentiation of the province of learning had taken place, the doctors of law might well undertake to study man himself after the garments of law were stripped from him. Not so to-day, when the field of learning is parcelled among so many doctors. Those of science, especially those of biological anthropology and psychology, and not alone those of law and normal society, are designated by the problems themselves and by the character of our era to play a conspicuous part in the making of peace and the reestablishment of order when the time for that business shall come.

To show more specifically the ground on which this contention rests, and to indicate two or three points at which the service of science is especially urgent, is the task for the few minutes remaining to me. What I have to say under this head may be fittingly introduced by the following quotation from Grotius:

> Aristotle, taking a description of man from his peculiar qualities, makes him an animal of a gentle nature, and in another part of his works, he observes that in considering the nature of man, we are to take our likeness from nature in its pure and not in its corrupt state.

The train of reflection initiatied by this statement is this: The principle of procedure followed by Aristotle and less faithfully by Grotius in dealing with man on the basis of his fundamental nature, is right as to broad outlines, but viewed in the light of modern natural history and anthropology is wholly inadequate as to details. Let me explain. The principle is right in so far as it "describes man from his peculiar qualities," using Grotius's phrase, and in so far as it "takes our likeness from nature in its pure and not in its corrupt state," speaking again in Grotius's phraseology. The inadequacy appears under two aspects, one pertaining to substance, the other to form.

Before treating of these two aspects specifically it will be well to state the case in a form which brings it to our own times and conditions: The whole vast body of discussion of man under western civilization, as this appears in writings on society, government, law, ethics and the rest, is radically defective in that it rests on no adequately scientific definition of man. Incalculably far-reaching as this criticism is, the warrantableness of it becomes clear and unescapable once the matter is approached from the direction from which Aristotle, and in part Grotius, approached it, and is followed through on the basis of later progress in the sciences of man.

To take up now the technical or scientific view of the matter spoken of a moment ago as having two aspects, one of substance, the other of form. This leads us to requisition that great province of natural knowledge in which Linnæus is the dominating figure, namely, that of the systematizer; and the equally great province in which Charles Darwin stands preeminent, that of inquirer into the origin of kinds of living beings. Only the most vital spots in the gigantic situation can receive attention here. Let us remind ourselves of Huxley's eminently just characterization of Linnæus as the supreme lawgiver of living nature. Reflect on what he did to advance man's interpretation of himself over what Aristotle had done. Aristotle had rightly, though only partially and wholly empirically, defined man "from his peculiar qualities," and had seen that logical consistency demanded that these peculiar qualities should have reference to man "in his pure and not in his corrupt state."

But it remained for Linnæus to bring out that this mode of defining man fixed his place not empirically or arbitrarily, but naturally and inevitably, in the vast *system* of living nature, and that it placed him at the head of this system. Paltry though Linnæus's contribution to man's understanding of him-

self was as compared with Aristotle's, when the *substance* of it is concerned, because of the *form* he was able to impress upon that substance his service to humanity was very great, for it amounts to a veritable natural revelation to man of what his place is in the system of the universe. I am convinced that his service in this has been rarely recognized with sufficient fullness either by scientists or humanists. Think a moment about what he really did on the basis of the knowledge that had been accumulated concerning the physical characters of animals and man. He was able to recognize man not only as belonging to the animal kingdom, but to the class mammalia, to the order primates, and to assign him to a genus, *Homo*, in that order. Then on the basis of man's "peculiar qualities," reverting again to Grotius's statement of Aristotle's method, he undertook to define the kind, or species man, and subdivide it into several sub-kinds or races. And here comes the point which, so far as man's own welfare is concerned, is most vital, though it is usually regarded in the lightest way or not at all, especially, I fear, by present-day biologists. What "peculiar qualities" of *Homo sapiens* were they to which Linnæus appealed in his efforts at systematizing the species? Why, those of habit, of location, of educability, of temperament, of esthetic impulse, of relation to law and government, and of rational and moral life. All this is set down after the usual synoptic fashion followed by Linnæus in the "Systema naturæ." So much for what this lawgiver of living nature builded into the great edifice of man's understanding of himself: On the basis of his physical attributes he assigned man *to* the natural order; and on the basis of his civilizational or spiritual attributes he isolated man *within* that order, and subdivided him into lesser groups.

Turn now for a moment to what that other master builder, Charles Darwin, put into the same edifice. Great as was Grotius's regard for and adherence to the laws of nature, he still was unable to conceive that some of man's most distinctive attributes could have come from this source. "Who for an instant would say," he remarks, "that the Christian precept of laying down our lives for others was an obligation of the law of nature?"[2] Yet exactly this obligation Darwin showed to inhere in the natural law of organic creation and existence, for he showed in a manner which has carried conviction to all critical minds that man in the whole scope of his being is a natural product, and he also accepted the criterion of self-sacrifice as the most positive of all for man's nature.

[2] "The Rights of War and Peace," Chap. II., Sec. VI.

I must pause a moment to call attention to the meagerness of understanding of Darwin's position in this matter. His own words leave absolutely no room for doubt. The opening sentence of Chapter III. of the "Descent of Man," the beginning of the discussion of the moral sense, is as follows:

> I fully subscribe to the judgment of those writers who maintain that, of all the differences between man and the lower animals, the moral sense or conscience is by far the most important.

Nor does he leave us in the least doubt as to a part at least of the meaning he attaches to moral sense. He says:

> This sense, as Mackintosh remarks, "has rightful supremacy over every other principle of human action"; it is summed up in that short but imperious word *ought*, so full of high significance. It is the most noble of all the attributes of man, leading him without a moment's hesitation to risk his life for that of a fellow-creature; or, after due deliberation, impelled simply by the deep feeling of right or duty, to sacrifice it in some great cause.

With the exceedingly important matter of Darwin's effort to bring this attribute of man into harmony with his hypothesis of survival of the fittest we are not now concerned. Enough for this presentation to know that he recognized the attribute in the fullest possible way, and held it to be as natural to man as any of his other attributes.[3]

From these excursions into the ideas and methods of Aristotle, of Grotius, of Linnæus and of Darwin, we are now prepared to extract from the vast accumulation of knowledge, ancient and modern, of the natural history of the human species, a summary definition of that species which would be a fairly adequate foundation for the discussion of and the practical conduct of man under civilization.

The most distinctive thing about this definition as compared with definitions, expressed or implied, that have usually passed muster, is its recognition of the necessity of being comprehensive—of including all the major groups of attributes of man—instead of focusing on one group with the theory that these are cardinal while all the others are secondary and tributary to it. In other words, the revised definition is made in accordance with the maxim "neglect nothing" which is of growing importance in taxonomic biology. Leaving aside the purely physical peculiarities merely for the sake of brevity and on the assumption that they are obvious to all, and without pretending

[3] Dr. George Nasmyth ("Social Progress and the Darwinian Theory," New York, 1916) has dealt more adequately with this aspect of Darwin's teachings than has any other author with whom I am acquainted.

to exhaustiveness, the definition runs somewhat thus: Man is a speaking, esthetic, religious, thinking, political, economic, moral and idealizing animal.

A cardinal thing about this definition is not merely its comprehensiveness, though that is greatly important, nor yet the finality of delimitation and sequence of the several groups of attributes; but the indubitable reality, and the basic functional interrelation of all the groups.

And do not fail to notice that while the assertions that man is an eating, propagating, mating, fearing and fighting animal are true also, they can not be included in the definition of man *as man* for the reason that they are equally true of all animals. We here see again the great importance of the natural history method; that is, the method of defining organic beings by *taxonomic groups*, first clearly recognized by Linnæus. Definitions of this sort are characterized as much by what they *exclude* as by what they *include*. Even a partially adequate treatment of this matter would necessitate a whole course of lectures. I can now do no more than assert dogmatically that a prodigious amount of not only false but, scientifically viewed, foolish theorizing about civilized man has been carried on because of failure to recognize this principle. For example, the "wolf" theory of modern business and politics comes under the latter stigmatization. A man and a wolf are animals of very different nature—of widely separated taxonomic rank, so that from the natural history standpoint it is simply ridiculous for the species *Homo sapiens* to try to act not in accordance with its own nature, but in accordance with the nature of some other species, as a wolf. How does it happen, one may ask, that men should have hit upon the wolf rather than upon the hog in attempting to shunt moral responsibility for their deeds from themselves to their animal natures? From a purely scientific standpoint one course is as justifiable as the other. A man might exactly as well rely upon his odor-producing peculiarities in his "struggle for existence" because a skunk does so, as to rely upon his rapacity because a wolf does. To taxonomic biology these cases are entirely parallel.

From the many lines of possible consideration which naturally radiate from this perception of the nature of man I select only one with which to end this paper. That is the radius which starts from the part of the definition which recognizes man to be an economic—a wealth-accumulating—animal. This is chosen for the reason that it seems to me to be the most important of all in this particular world crisis. Despite the

obviously enormous importance for the future of international relations, of man's political nature, his economic nature is still more important.

I am unable to understand how any measurably intelligent and thoughtful person can fail to see the futility of hoping for and working in behalf of immunity from military war among civilized peoples so long as these same peoples conceive industry and commerce as being in their essential nature a sort of war. If all the nations of the world, as well those engaged as those not engaged in the present military struggle, are in very truth planning for the "war after the war" about which we have heard so much, proposals looking toward permanent peace among the nations are as futile as would be proposals to reclaim the tropical lands of the earth by so shifting the earth's axis as to make those lands temperate instead of tropical.

I fully agree with the view so admirably expressed by President Wilson in his epochal war message that no basis for a peaceful and mutually advantageous compact among nations exists so long as the present German theory of the state prevails in even one powerful member of the "family of nations."

But even were all government claiming responsibility to itself and God alone done away with, the civilized world as now constituted would be a long way from insured against devastating wars. Men's fighting instincts do not depend alone or even chiefly on the form of government under which they live. Now, since economic needs and tendencies are not less strong under popular than under autocratic rule, and since the group of attributes upon which economic life has depended has dominated all other groups in the later decades, the good of mankind for the future is really as much dependent on bringing these attributes into proper subordination and correlation with the other major human attributes as on anything else whatever.

Speaking in terms of organic evolution, this world war is a time of metamorphosis of world civilization. If the titanic transformation taking place before our eyes shall be progressive rather than retrogressive the economic system of civilization will, we may confidently predict, emerge no less profoundly modified than will the governmental systems. "This commercial age of ours" must be approaching its end if civilization is passing to a higher plane. Economism, as several generations have understood the word, does insufferable violence to some of the profoundest instincts, the most precious interests of human life, and can not survive in that higher civilization

toward which the imagination and the ideals of all thoughtfully good men are turned.

What part has science to play in the yet unacted portion of the mighty drama? That is the specific question to which this address would contribute something. An attempt to answer the query in detail is neither possible nor necessary in this place, but a reply in broadest outlines is ventured.

1. Biology may undertake to convince the world that the prevalent custom of invoking the doctrine of the survival of the fittest in palliation, even in justification, of unhuman methods in business, politics and war rests on a deep misunderstanding of the evolutionary processes.

2. Anthropology may undertake to convince those historians, economists and publicists who have been committed to the extreme materialistic conception of human history and the extreme economic theory of human society that these doctrines imply a definition of the human species which is found to be very inadequate and largely fallacious when viewed in the light of natural history.

3. Chemists, physicists, geologists, agriculturists and breeders of plants and animals may undertake to convince the world that the latent resources of the lands and waters of the world are sufficient to insure the continued progress of our species in civilization, provided civilization be understood to consist in the harmonious growth and interplay of all the great groups of attributes which differentiate man most sharply from other animal species, and provided that the resources of the whole earth are utilized in accordance with the dictates of common wisdom and common justice and developed through the applications of science. And finally,

4. Scientific men and women of the whole world might, it would seem, unite in an effort to convince the statesmen, diplomatists and lawyers upon whom alone, according to precedent would fall the stupendous task of making peace and reestablishing political and economic and social order at the end of the war, that the voice of science ought to be far more definitely and authoritatively heard in the business than it ever has been before, this voice to be particularly invoked in the two supreme problems of colonial possessions and the use of the seas.

THE APPLICATIONS OF SCIENCE[1]

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THIS assemblage needs no definition of science; nevertheless for our present purpose I shall characterize science as the disclosure of the facts of nature, and the orderly study of such facts with a view to the establishment of their interdependent relations.

If we ask why we should concern ourselves with the examination of the facts of nature or with the interdependences which seem to connect them in the relation of cause and effect, we may find at least two fundamental reasons and these are:

1. As a response to the innate curiosity with which we are endowed regarding the universe, its constitution, phenomena and laws of evolution: or otherwise in response to the joy of achievement and conquest which we feel in being able to enter some little way into the *arcana* of nature.

2. In order that the phenomena disclosed or the laws established may be applied in the service of humanity.

It is to this second purpose that I am to specially direct your attention for a few moments.

In nature and by themselves all facts are of equal importance or value. Or, rather, the concept of value or importance does not and can not attach to a fact or a law of nature as such. Rather, the facts and laws of nature are beyond value and do not admit of comparison as to relative importance. It it only as they come to be applied that they take on relative value or significance. This value or significance is therefore something wholly extraneous to the fact or law itself, something contingent on the particular circumstances which surround its application to the demands of civilization.

Again it will perhaps be admitted, as a broad generalization, that until the facts of science have reached the status of application in the service of humanity, they have not reached their widest plane of significance, nor have they justified to

[1] An address presented in a symposium on "Coordination and Cooperation in Research and in Applications of Science," held during the meeting of the Pacific Division of the American Association for the Advancement of Science at Leland Stanford Junior University, April 5 to 7, 1917.

the full the human energy which may have been expended in their disclosure. The progressive widening of the scope and significance of a fact of science may be noted in three stages.

1. Its discovery or establishment by the worker in some field of science. So long as it does not go further, this fact is known only to its discoverer and to the omniscient intelligence pervading nature. It gives the discoverer a thrill of the joy of conquest; or it may awaken feelings of awe or wonder at the sublime harmonies of nature.

These, however, are purely subjective. They relate to the discoverer alone. The significance of the fact has not yet passed beyond the boundaries of his being.

2. We may next suppose that the fact is spread abroad and made a part of the common stock of scientific knowledge. Its significance now becomes greater. It helps all workers in science to better understand the secrets of the universe; it may help humanity broadly toward a higher and nobler appreciation of the works of nature. The significance of the scientific fact is thus enormously widened and deepened. It has not yet, however, passed beyond the domain of intellectual or esthetic appreciation.

3. If now in the third stage we suppose that some application of the observed fact or established law may be made which will aid in curing disease, in giving us new comforts in the home, in rendering life and its activities safer or fuller, we have the realization of the final stage in the widening significance and value of this fact of science.

We may perhaps imagine Oersted's intellectual gratification in developing a coherent formulation of the laws governing the mutual relations of a magnet and an electric current.

We may likewise imagine the intellectual satisfaction with which the scientific world of his day received this formulation. The significance of Oersted's work, had it remained bounded by these results, however, would fall far short of the significance in the world of to-day, of the electric motor, with its countless points of relation to our comfort, safety, pleasure, and appreciation of the content of life.

We may imagine the spiritual exaltation with which Crookes about 1880 glimpsed his so-called fourth state of matter. Those of us above forty years of age will probably remember the awed and exalted state of mind with which we entered into some knowledge of his work.

However, had Crookes and others working in the same and allied fields gone no further, and if no application in the service

of humanity had been made of the early observations of Crookes, Roentgen, Becquerel, the Curies and others, then would the influence on the human race or the significance to it of these scientific discoveries have been small indeed compared with the present significance of the cathode ray and the various radioactive substances, a significance which seems likely to grow in the future in ways and to an extent of which we can gain no present vision.

Illustrations might be multiplied beyond measure, but it is unnecessary for our purpose. It will, presumably, be admitted that until a fact of science has realized some useful application in the arts of life or in the service of humanity, it has not reached its highest and widest significance. Short of such application it stands indeed as a conquest gained in the struggle with nature, it stands as a fact of mental achievement, it stands as a fact in relation to the intellectual life of the discoverer and perhaps of the intellectual lives of thinking men and women the world over; but it has not yet reached the status where it may be counted as a factor in the material or outward content of life, and to this extent at least it has failed of realizing the full measure of its significance to humanity.

I should perhaps note at this point that not all facts of science seem equally applicable to the immediate service of humanity—at least in outward and material ways. Indeed many of the facts of science seem hopelessly removed from the opportunity of application to the arts of life; for example, portions of advanced pure mathematics and much of astronomical research. This does not imply that for this reason such fields of science are the less worthy of intensive cultivation than those where the opportunities of application seem more probable. In the first place no one may dare predict the future significance of any fact of science, no matter how remote it may seem from useful relation to the needs of humanity at the present moment. It is the glory of the worker in pure science that he is not concerned with the question of application as such; *that* he leaves to others and to the future. He is endeavoring simply to uncover some portion of God's truth and to place it on deposit in the great storehouse of scientific knowledge, whence it may haply be drawn in the fullness of time to serve some purpose now far below the horizon of our thought.

All this, however, does not affect the truth of the broad thesis that when such facts of science shall have been drawn out of the storehouse and applied in the service of humanity, then will they reach the full measure of their potential signifi-

cance to humanity and then will they have fully justified the energy expended in their pursuit and disclosure.

And so to close this phase of the discussion I repeat that a fact of science until it has been applied in the service of humanity is potential in its relation, at least to our outward and material life. When it has reached the stage of useful application, this potential relation or significance has been transformed into an actual and real significance. It has then taken its place as a factor in the life of the human race.

The problem of the application of science may be phrased as the problem of bridging the gap between science on the one hand and the needs of humanity on the other.

We find that the problem thus broadly stated divides under perhaps two typical forms or types:

1. Given a fact of science, what are its useful applications?

2. Given a demand or need presented by the arts of life (using this term in its broadest sense), what facts of science may serve as significant factors in meeting the demand or in supplying the need?

The history of science with reference to its application in the arts of life shows abundant illustration of both types of problem, while naturally many cases are of an intermediate or mixed type.

In particular the second type presents two variations: (*a*) Where the needed facts of science have presumably been already developed and are stored away ready for use on demand, and the problem becomes simply that of finding or identifying them among the vast store open for inspection. (*b*) Where the needed facts of science have not been developed and the problem becomes that of organizing and directing an investigation in science along specific lines and with reference to the solution of a specific practical problem.

The two factors which are most likely to be of significance in the first typical problem are:

(*a*) Imagination or vision.

(*b*) Wide acquaintance with the needs represented by the arts of life, especially when expressed in terms of their scientific factors or elements.

For the problems under type two the factors which are most likely to be of significance are:

(*a*) Wide acquaintance with the results of scientific research along lines likely to stand in a fruitful relation to the practical problem in hand.

(*b*) Such degree of vision or imagination as will aid in

identifying such scientific facts or relations as are likely to prove of special help in connection with the particular problem in hand.

(*c*) Resourcefulness, energy, persistence, patience, capacity for analysis, synthesis, deductive logic, and all the other qualities of mind and character which we associate with the successful worker in special fields of science.

With regard to these typical problems a few observations.

The first problem may arise in connection with the discoverer of the fact or relation. The fact itself having been established, the question of its possible application may arise. It is an interesting thought that, purely as a matter of probability, the chances are, I believe, overwhelmingly in favor of the existence of some, perhaps many, direct and useful applications in the arts of life, even in the stage of advancement of the present day. It is a further thought of the deepest interest that thus far, at least, we have developed no scientific method for establishing the connection between the facts of science and their potential applications. As a broad fact or at least as a high probability we may say that the application doubtless exists: how may we discover it.

To our present contracted view it seems to call for what I often like to term the all-seeing eye; an intellectual eye is implied, of course. If we may postulate such an eye, and this is equivalent to postulating omniscience, we may picture this eye roving over the field of human endeavor with special reference to what I have termed the arts of life, and unerringly resting on those arts, or on the problems connected with such arts, as would offer a field for the helpful application of the fact of science in question. But, alas, we have not attained to this stage of evolution. Rather we are looking through a narrow aperture with clouded vision and can only make out imperfectly here and there uncertain features of the landscape which lies before us. To leave the figure of speech we need some means of approaching an orderly study of method, whereby relations between facts of science and problems of life may be more readily correlated.

With vision or imagination and some acquaintance with the problems presented by the arts of life, applications may be found, but the whole process is, for the most part, without method and depends on a fortuitous combination of happy circumstances rather than on scientific procedure. And so we conclude that in perhaps the most important of all possible scientific problems, that of the application of the results of

scientific work to the arts of life, we are wholly without a scientific method. Why should there not be a kind of super-science, a science which should have for its purpose the correlation of the immediate results of scientific work with the arts of life and thus the realization, at the earliest moment and in the fullest degree, of the potential value of the results of scientific work?

With regard to the second problem the condition is much the same as with the first. The demand here is for some fact of science applicable to a specific problem arising in connection with the arts of life. Here again the interesting thought occurs that in all human probability there now exists stored away and perhaps lost sight of in the storehouse of science, some fact, observation or correlation which will furnish the solution desired, or at least serve as an important factor in the prosecution of the problem. This is a reflection over which we may well ponder, restive at the thought that beyond all human probability there are now stored away in the annals of science facts of observation or generalizations in the form of laws which would have fundamentally important applications to specific problems now pressing for solution. These problems are before us and engage our attention. The arts of life urge speedy results. The necessary scientific work has perhaps all been done and the results are stored away beyond the scope of our immediate vision. How deplorable the situation. Why have we pursued science with such zeal, and taken no pains to provide for the better utilization of the facts when once disclosed?

The situation results further in the most serious economic waste. It results in the rethreshing of old straw, in the rediscovery and recataloguing of the facts of science when once should have been enough.

Is there not some way, when once a fact of science has been disclosed, of so cataloguing it and placing it on exhibit that it will not be necessary to rediscover the same fact a few years later, when there may arise some problem in the solution of which it must play a significant part?

It will be said, and with truth, that oftentimes the rethreshing of the old straw and the rediscovery of the already known fact arise from indolence or from negligence to search the records for such material as may be found. This is often the case. It is true, on the other hand, however, that there is urgent need for improvement in our system of keeping the record, and also that the scientist best adapted perhaps to work

out the practical problem is not always the best adapted to make a search of the record for the facts of science which may be of aid in dealing with the problem.

What seems to be needed is the development of a science of the use of science—a science whose purpose shall be the saving of waste energy in searching for scientific facts or principles applicable to specific problems, and likewise the development of economic and effective methods in seeking for useful applications of the elements of scientific knowledge.

The practical question immediately arises, as to the possibility of realizing anything effective in the way of such a science. What should be its factors, what its methods of procedure?

The answer to these questions requires more wisdom than I can command, but some few items, at least, are fairly obvious.

Quite aside then from the question of practicability, let us seek some of the more obvious elements of such a science. Among these the following may be noted:

1. A clearing-house or classified storehouse for scientific knowledge.

2. A clearing-house or classified storehouse for the diverse needs of humanity.

3. A staff of scientific workers whose duty it shall be to gather, analyze and prepare scientific data in various ways with reference to the development of points of application with the needs of humanity.

4. A staff of workers whose duty it shall be to gather, analyze and prepare in various ways data relating to the needs of humanity and with special reference to the development of relationships with the underlying scientific facts.

5. A staff of scientists whose duty it shall be to work with the material prepared by these corps of workers and whose energies will be directed toward the development of relationships between these two classes of materials, the facts of science on the one hand and the needs of humanity on the other.

The mere statement of this schedule of fundamental elements of such a science will bring a smile, perhaps, by reason of its impracticability, at least at the present time and in any large sense. The field seems too great to attempt its compass by any corps of workers of which we can readily conceive. When we consider, on the one hand, the existing facts of science, together with the generalizations and principles or laws which are intended to correlate them, and on the other the needs of humanity as expressed in matters to which science might stand

in a helpful relation—when we picture for a moment the vast expanse of this field, the millions of items of which some cognizance must needs be taken, and also the astonishing rate at which the store is accumulating, the task seems quite hopeless in any extended or comprehensive sense.

Leibnitz, I believe, has been indicated as the last great scientist whose mind could be said to have compassed practically the then existing store of scientific learning. Regardless of the degree of accuracy with which such a statement can be made, it is very sure that no mind of the present day can do more than hold in view the content of a very small corner of the constantly widening field of scientific activity. And as the years go by the condition becomes ever more aggravated in this respect. We are continuously adding to the scope and variety of our store, its extent both in number and diversity of character becomes daily more bewildering, and in corresponding degree the task of developing an effective science of the use of science becomes seemingly ever more and more hopeless.

Confronted with such a condition, what should be our attitude? Should we continue to do nothing and allow the content of the body of science to increase without regard to the question of its application, or should we make some attempt to improve the existing condition. Is it not worth our while to attempt at least to take the measure of the undertaking in certain limited areas of the field, or to do some little even if a comprehensive treatment lies beyond our capacity?

I believe that this is our clear duty. Because we can not do everything which an ideal treatment might indicate, it does not follow that we should not do what we may. It will mean a distinct effort along measurably new lines. It will imply assemblage, analysis, selection, synthesis in various ways, classification, coordination and the development of ways and means of detecting and setting forth what the mathematician might term systems of point correspondences between the two classes of material, scientific facts on the one side, human needs on the other. May we not anticipate that one of the triumphs of the twentieth century will be the making of some effective progress toward the establishment and development of a science of the use of science.

RACE SUICIDE IN THE UNITED STATES. II

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CAUSES OF THE LOWER BIRTH RATE IN THE CITY

One of the most obvious reasons of the lower birth rate in the city is the fact that fewer of the women of child-bearing ages are married. In the urban communities of the New England States only 53.9 per cent. of the women 15–44 years are married, widowed or divorced, while in the rural communities the percentage is 63.8 per cent. In the East North Central States the percentages are 59.2 and 63.2, respectively, while for the United States, as a whole, they are 57.8 and 64.6. Thus we see that, on the average, the proportion of the women married, widowed or divorced is about 7 per cent. less in the city than in the country. As has been shown above, however, the proportion of children to married women is much smaller in the city than in the country. Therefore, although the fact that many more women in the city do not marry or marry relatively late in life is an important cause of the low birth rate in the city, it is by no means the most important one.

The chief causes of the lower birth rate in the city may be summed up by saying that the people in the city more often voluntarily limit the size of their families than the people in the country. When we undertake to inquire into the causes of voluntary limitation of the family among city people, we find such widely different motives in operation in different classes of people that it becomes necessary to discuss the forces controlling the birth rate in each of these classes separately. I have divided the city population into four classes. The basis of the classification is the family income.[8]

(1) The poor, those with an income below $750 per year. This class is composed chiefly of unskilled workers. (2) The comfortable, those having an income of from $750 to $1,500. Most skilled workmen belong to this class, also many people in clerical positions. (3) The well-to-do, those having incomes ranging from $1,500 to $4,000 or $5,000. Most professional men and men in executive positions in industry and commerce belong to this class. (4) The wealthy, those with incomes of $5,000 or over. Capitalists and those on the road to become capitalists belong to this class.

In the first class there is but little voluntary limitation of the size of the family. The two most important reasons why this is the case, are: (1) The people in this class do not know how to limit their families, (2) they do not care a great deal about limiting them, because they do not feel burden of a fairly large family as keenly as people in the higher classes.

There can be no doubt that the poor would practise voluntary limitation of their families much more than they do if they knew how. But as yet the laws forbidding the dissemination of such knowledge are quite successfully enforced against the poor. (In my judgment this is the only class of the population which the laws prevent from securing this knowledge and they bid fair to become ineffective even against them in a short time.) They have only been effective this long because this class depends largely upon free agencies for such medical attention and nursing as it secures, and because the members have no personal friends among doctors, nurses and others, who might tell them how to limit their families.

I believe, however, that even if the poor knew how to limit their families as generally as members of other classes, they would not put their knowledge into practise to the same extent. It is the customary thing among the poor to look forward to the economic aid of the child as soon as he or she can be put to work. In the sweating industries mere babies often add their pittance to the family income by "helping mother" with her work. Even where child-labor laws and school laws are well enforced, the parents can count on the aid of the children as soon as they are fourteen or fifteen years old. Not only does the child of poor parents cease to be a direct burden upon the parents very early, but there are usually several years in which it contributes more than its "keep" to the family income. Thus a family of four or five children may render the parents substantial aid for ten or fifteen years or even more. The parents very generally expect to get back the cost of the child before it strikes out for itself and they usually succeed. It may seem to many people that this attitude towards children is exceptional and is not a very important factor making for large families. I feel certain, however, that this attitude towards children is very general among poor people. The parents themselves were brought up to expect to go to work as soon as they were able and they expect the same of their children. The experience of those who have to do with the enforcement of child-labor laws shows that people in the poorer classes want their children to leave school and go to work at a very early age and that the children are quite willing to do so. This is the usual attitude

of poor people the world over. Hard conditions of life and simple forms of work make it necessary and possible for children while yet very young to help their parents and it is customary for them to do so. Old world ideas brought over by the immigrants also work in the same direction. The peasant economy of Europe has a place for the labor of the child and only too often the immigrants see no reason why the child should not go to work as young in this country as he would in the old country.

Many times the child begins to assist the parents at their work long before it is permitted to work regularly. It can do this quite easily, because both men and women do unskilled work. When the time comes that the child can leave school, it finds comparatively little difficulty in getting the same kind of a job as father or mother or a similar one. Children whose mothers work at home in the sweated trades can acquire all of the skill needed to do any of the work by the time they can leave school. When the boys are too big to work at the sweated trades they are able to go to the wharves with their fathers or do rough labor on construction work or any other of a thousand jobs which require no special preparation.

I would not imply that boys and girls in this class always do the same kind of work as their parents, but I do believe that the great majority of them do work of the same general nature. I should say that the boy whose father is a longshoreman and who himself becomes a deliveryman is staying in the same general class as his father. Similarly the boy who does the unskilled labor in a new subway is following in the steps of his father who is the janitor of a tenement. We are too apt to forget that only a small proportion of children can ever rise from the general class into which they are born.

I have many times been amazed at the utter lack of ambition among the children of unskilled laborers. But when one canvasses the situation carefully, one finds nothing in this attitude of children to cause surprise. They have been brought up to expect to go to work at an early age, their parents have never tried to instil into them the desire to better their lot. They have attended schools where no mention was ever made of occupations open to them, or if occupations of different kinds were brought to their attention, no efforts were made to inspire in them a desire to get into better occupations than those of their parents, and they have not been prepared to enter such occupations if the desire for them was implanted. In a word, everything in the life of the child of the poorer

classes tends to press it into the mode of life of its parents while almost nothing urges it to a different mode of life.

There are forces at work now, however, which seem to me to be bringing about a change in the attitude of parents in this class towards their children, and also to be breaking down the passive acceptance by children of the rôle chosen for them by their parents. More stringent child labor laws, better enforced, are making the children dependent upon their parents for a longer time and thus rendering it less economically advantageous for them to have relatively large families. Going hand in hand with the movement to prevent too early work among children is the movement for vocational guidance and occupational training. In so far as these movements arouse ambition in the children of the poorer classes and supply the training to help them realize their ambitions, we may expect to see them become less and less an economic asset to their families. As this takes place, there is not the least doubt but that the birth rate will fall.

It may well be that the effects of these movements on the birth rate in this class will not be very marked in this generation, but they will be in the next. Those who have themselves risen from the poor class will want to maintain their new standards and give their children at least as good a start as they themselves had, and those who wanted to rise, but were unable, will hope that by having only a fair-sized family they can give their children such advantages that they can rise. Thus the effects of better education and a longer period of childhood and preparation are certain to bring about a reduction of the birth rate.

It is not likely, so far as I can see, that the poorer classes will ever have as low a birth rate as the other classes. There will always be those who must do the unskilled work of the community and their children will, for the most part, take their places with the minimum of preparation allowed by law. Under such conditions the children of this class will naturally cease to be an expense to the family sooner than the children of the higher classes, and they will also be able to add something to the family income for several years before striking out for themselves. Thus in spite of greatly improved conditions children will always be more valuable economically to the poorer classes in the city than the other classes.

Another reason why I do not believe that the birth rate of the poor class will ever fall as low as that of the higher classes is that the poor class will always contain a greater proportion of improvident ne'er-do-wells than the other classes. People

who never look to the future, who make no plans for their own lives, who care little what becomes of their children, will always have large families. The motives of prudence and foresight operative in the higher classes are not operative among such people. No matter how widely the knowledge of birth control may be disseminated people who are shiftless, improvident and perhaps sub-normal will never restrict the size of their families to any appreciable degree.

Even though the poor class in the city has a rather high birth rate, it does not have a very high rate of natural increase (excess of births over deaths per 1,000 of the living population). If the rate of natural increase of the city population as a whole is about 5 or 6, then the rate of natural increase among the poor probably does not exceed 6 or 8. The reason it is not larger than this is that the death rate in the poor class is higher than that in any other class. The Children's Bureau has recently shown that infant mortality rises as the father's income becomes smaller. We also find that insurance companies charge a much higher premium on insurance sold to the poor class than to other classes. Moreover a comparison of the death rates of such cities as Boston and Indianapolis shows that the death rate of the former is considerably higher than that of the latter. The death rate of Fall River, Massachusetts, is still higher than that of Boston. It is, of course, impossible to tell what proportion of the people in these different places belongs to the poor class, but no one can reasonably doubt that it is greater in Boston and Fall River than in Indianapolis.

THE COMFORTABLE CLASS

IN the second class, voluntary limitation of the family is widely practised, though it is by no means universal. There are many people in this class who look upon their children in much the same way as those in the first class. In so far as this is the case, there is no need to dwell upon the motives at work. But there are also many influenced by motives that lead to the desire for a small family.

The skilled laborer who believes in the restriction of output and in the limitation of union membership can readily see the advantages in limiting the size of his family. If it is a good thing, from his standpoint, to control the amount of labor available for doing certain kinds of work then it is a good thing not to raise more children than he can find places for in his own trade or other trades of the same grade. A great many skilled mechanics have small families for no other reason than that

they believe this the most effective method of restricting the amount of labor and therefore of raising wages.

Many other people in this class raise small families because they hope to be able, thereby, to give their children better opportunities to rise into the higher classes. Many and many a family can be found among skilled laborers and clerical workers putting forth its utmost efforts to give at least one of the children a better start than its father had. In such cases, the child instead of becoming an economic asset at fourteen or fifteen years of age becomes an increasingly heavy economic burden in the years after he leaves the common school. Not only is the child a charge for a much longer period, but in the degree that the parents are successful in launching him upon his career in a higher class, they must expect to forego any return on their investment, for it takes so long to attain even a moderate degree of financial success in these higher classes that parents seldom live to see their children achieve it.

Of equal effect with ambition for one's children in causing restriction of the size of the family is ambition for oneself. There are many men in this class who feel that children would be a hindrance to them in attaining a higher position. There are also many women who have social ambitions or who desire to continue their work outside the home after marriage. In either case children are not wanted and voluntary limitation of the family is practised. Since, however, personal ambition is much more common in the third class than in this, I shall not discuss it further here.

The lack of training for women in home-making which is so prevalent among all classes of city women shows its effects most markedly in this class. The girls usually leave school after they have finished the grades or early in their high-school course and work for several years in factories, stores or offices before they are married. The work they do is very largely unskilled and requires little thought or close attention. In many factories they repeat a single simple process over again and again until it becomes purely mechanical. In the stores only a few ever learn more than the simple mechanical parts of salesmanship. Even in offices as stenographers and filing clerks, their work is but little less mechanical than in factories and stores. In any event the work of the girl who expects to work only until she gets married very seldom offers much opportunity for her to develop responsibility, self-reliance or foresight. Instead of preparing girls for home-makers, such work as they do induces careless habits and an indifferent attitude towards work of all kinds which is demoralizing in the extreme. These girls never

learn to regard work as the normal and proper condition of life. They do not know what it means to find work interesting and to put the best of themselves into it. They rather come to regard work as a necessary evil to be endured for a given length of time daily either because they must work to live or because they need the money to have a good time outside of working hours.

The girls are not primarily to blame that they so regard their work. The organization of our industrial system is such that most girls never get a chance to do work that is interesting to them nor do they ever have their attention called to the opportunities for self-expression in their work. It is not the least surprising, therefore, that these girls have never developed the qualities which make a successful and happy wife and mother. Such qualities as patience, economy, foresight, good taste and adaptability—essentials to a happy life under all conditions—are not to be acquired with the taking of the marriage vows; they must be developed slowly through the years. In my judgment the work of these girls not only does little to help them develop such qualities, but often actually aids in developing other traits of character which unfit them for home life, *e. g.*, carelessness, shirking, selfishness, irresponsibility and vulgarity. The woman who looks upon her daily life in the home as she looked upon her day's work in the factory or store before she was married is quite certain to find little there which will compensate her for raising a family. When this attitude towards the home exists, when all the good things of life are thought to lie outside of the daily routine of home life, family limitation will be practised if the woman knows how.

Although the birth rate in this class is considerably lower than in the first class I believe that the rate of natural increase is not much different, for the death rate is also lower. But it may well be that in recent years with the improvement of the public health agencies administering to the poor the rate of natural increase of the poor has come to exceed that of this class. Unfortunately we have no very conclusive evidence on this point.

THE WELL-TO-DO CLASS

In the third class voluntary restriction of the size of the family is almost universal. In addition, late marriages and celibacy contribute to a very low birth rate. The motives leading to late marriage and celibacy do not need much special attention because they are the same, in general, as those leading to the rearing of small families among those who are married. It

may be that the ease and comfort in which both bachelor men and women can live in the cities are motives which of themselves lead many to forego marriage, but I believe that ambition in various forms is the most potent motive leading to celibacy, as it is to family restriction.

Most professional and managerial positions offer abundant opportunities for advancement to capable, wide-awake, energetic, men and women. Honor and wealth are the rewards of diligence in these positions. The ambitious young man who goes into business hopes soon to leave the well-to-do class and join the wealthy as do many who go into the professions. There are many in the professions who do not care to leave this class, but rather who are ambitious to gain recognition through scholarly or artistic work, which is more dear to them than wealth. In either case—in seeking honor or wealth, or both—personal ambition is the dominating motive in life and has a great deal of influence upon the size of the family raised.

The young man in business who sees vistas ahead in which he may exert power through wealth has little time or inclination to give of himself to his family. He may be quite willing to meet the expenses of a relatively large family; but he is so immersed in his work that he is likely to forget to be human. He probably expects his wife to shoulder the entire burden of worry and care at home, so that he will not be distracted from his work. The wife soon becomes weary of bearing her burden alone and is ready to take measures to prevent it from becoming greater. So it is that the ambition of the father lies at the basis of family restriction in many cases.

Again the father may feel that he needs all the money he can possibly save to further his business plans and so takes means to prevent the coming of children. He often feels also that he will be hampered in his freedom of movement by even a fair-sized family. Then there is always the element of chance in business, and a man may not be willing to give hostages to fortune until he can be reasonably sure that he can redeem them. In the professions the situation is much the same, with the exception that the goal is more often recognition of some kind than mere wealth. Better than wealth to a lawyer may be the appointment to the Supreme Bench, better than wealth to a physician may be the discovery of some new means of aiding mankind, better than wealth to the engineer may be the successful completion of some public work, *e. g.*, a Panama Canal, better than wealth to the scholar may be the writing of an essay which will inspire good thoughts and noble ambitions

in his fellows. But the way to success in the professions is slow and laborious, and even a moderate-sized family may make the ascent much slower and more difficult.

There are also numerous cases in this class in which the man marries so that he may increase his acquaintance among men who may be of help to him through the social activities of his wife. Many such marriages are childless, while many more have only a single child.

It is quite likely, however, that only a small proportion of the women who spend much of their time and energy in *social life* do so with the object of furthering their husbands' interests; most of them have social ambitions of their own. The care and expense of even a single child will seriously curtail the social activities of a woman of this class and so, many times, children are sacrificed to social ambitions. Children tie a woman to the home rather closely for a good many years if she gives them a true mother's care. They are also expensive. No doubt the woman in this class very often has to make a choice between another child and some cherished object which will further her social ambitions. An automobile, a new home, new furniture or more expensive clothes will each and all enhance one's social position and keep one before the attention of one's friends, while another child will withdraw one from their attention for a considerable time and make it more difficult to appear so well in their eyes. Only too often the temptation of the easy and immediately pleasant way out overcomes them and they shirk the real duty of a woman.

Like the mistrained or untrained women of the lower classes, women of this class who "go in for" social life see no satisfaction to be derived from the daily routine of the home. The dearest objects in life lie outside the home. Nowhere among their friends and acquaintances do they encounter any disapprobation of the frivolous, meaningless lives they are leading, for they are all of a feather. If it is to women of this type that the charge of parasitism, so often heard now-a-days, refers, it is very largely justified.

Again there are many women in this class who want a "career." They want to be independent economically and socially. Some of these women do not marry, but more of them do marry, although relatively late. Of those who do marry, many regard their work essential to the highest self-respect and self-development and therefore find no place in their lives for the bearing and raising of children. Happily there is a reaction, in late years, from the extreme type of feminism prevalent about a generation ago, which taught that for a

woman to be dependent on a man for support was disgraceful and not to be tolerated by any woman of strong character.

But by no means are all the women of this class of the type that would prefer not to have children. The majority, without doubt, are women who find a satisfying existence in simple home life. But even such women do not desire large families, for they find the raising of children in the city a task of ever-increasing difficulty.

As I have watched the child life of the cities, especially among this class of people, I have often wondered that they tried to raise children at all. Children are not wanted in most apartment houses in desirable sections of the city, nor will single houses be rented to families with children if those without can be secured. Open places for play, close at hand, are generally lacking, while a private yard where one's children hold undisputed sway is almost unknown. Thus the naturally venturesome spirit of youth has no place in which to express itself in ways useful to the child and not troublesome to others. On the other hand, the opportunities to get into mischief seem to be unlimited.

Our cities to-day seem to be organized for the repression of the natural life of the child rather than to encourage its normal expression. *Don't! Don't! You must not! Get out of the way! What are you doing here!* are apparent everywhere, while, *Come on! Take part! Enjoy yourself! Here is a place for you!* are scarcely visible anywhere. Because of these conditions it is not unlikely that, in this class where standards of living are high and income not sufficient to permit of much help in the home, one child causes more work and worry than several in the lower classes.

But aside from the care and expense of raising children while they are comparatively young, parents in this class generally have to provide for their children for a much longer period than those in the lower classes. At the age the child of the poorer classes begins to be self-supporting the child in this class begins to make greater demands upon the economic resources of its parents. Prevision and foresight are well developed in these people and consequently they make definite plans, so that their resources will meet their own needs and provide a good start in life for their children. Expenses during high school, college, technical school and possibly even for a year or two while getting a foothold in some profession, generally strain the family resources to the limit when the family is small. Therefore a large family is not desired.

The desire for travel is another motive often leading to the restriction of the size of the family in this class. It needs no

argument to show that children make travel more difficult both from the standpoint of expense and from that of leisure. Each child born increases the normal expenses of the family and makes it more difficult for the parents to take their children with them or to leave them behind when they travel. Thus with the growth of the family the likelihood of being able to travel decreases. Therefore, where there is a strong desire to travel, a "trip" very often is chosen as the alternative to another child.

The desire to attain culture is also a motive leading to family restriction in many cases. A certain amount of leisure and freedom from harassing care are necessary to the development of a cultured personality. A large family of children or even a moderate-sized family is apt to make the work and the worry of maintaining class standards so difficult that one will have little energy or inclination for anything beyond the daily routine. The realization that this is likely to take place causes many people to raise only one or two children. They feel that the sacrifice of self-development involved in rearing more is too great.

We have no very extensive data bearing on the birth rate and death rate in this class, but such data as we have seem to justify the conclusion that there is no natural increase. My own belief is that this class does not produce enough children to keep up its numbers, but we must await further investigations before we can be certain on this point.

The Wealthy Class

There is no sharp line dividing the fourth class from the third either in regard to the motives leading to family restriction or the rate of natural increase. Family limitation is almost universal in the fourth class and ambition in one form or another is the most powerful motive leading to it.

This class is quite small, comprising not more than two or three hundred thousand families (judging from the federal income tax returns). The great majority of the men belonging to it are men having incomes near the lower limit. Most of these men hope very soon to increase their incomes and are struggling desperately to rise. Nowhere in our population is the competition more strenuous than between men who have attained some measure of success and whose appetite for it is therefore insatiable. These men are "climbers" in their lines and very often their wives are social "climbers." Thus the chief interests of both husband and wife lie outside the home and children are regarded as a burden. Such people have no real home life and do not care enough for it to stop scrambling

for position. The husband only too often thinks of his wife as the means to a larger acquaintance among people who may be able to help him along and the wife regards the husband and home merely as necessary incidents to respectability. The result is that their families almost never comprise more than two children and very often none at all.

These "climbers" have neither accumulated wealth nor do they have very assured positions in society. They have therefore nothing definite to bequeath to their children. They have no pride of family urging them to leave descendents to carry on the family name and traditions; they have no definite position in the community, which they can be assured of transmitting to their children. These people are themselves adrift, they know not whither they are bound, and many of them feel, in their more serious moments, that life is so uncertain and there is so little worth while to be got out of it that they will save trouble all around if they have no children.

On the other hand, among the wealthy, whose position is assured, there is a certain amount of pride in one's family, leading them to rear children to carry on the family name and fortune. They have not only wealth but a much-coveted position in the community which they can command for their descendants. This portion of the wealthy class probably more nearly reproduces itself than the "climbing" portion.

Undoubtedly the sheltered lives of ease and luxury led by many girls in the wealthy class and even by some in the well-to-do class disincline them to undergo the hardships of bearing and rearing a family. To a girl who has been brought up in the belief that her own whims and desires are of prime importance and that all values are to be judged by these pampered inclinations it is often inconceivable that she should deliberately do any thing to bring herself pain and work and worry and probably even deprivation of some customary luxuries. Such girls brought up apart from the stern realities of life are not capable of judging values aright. They know little of the feelings and values which grow up naturally when men and women struggle side by side, help to bear one another's burdens, share sorrows as well as joys and, above all, live close to the great streams of simple, work-a-day humanity. Women whose only passion is for ease and luxury lose touch with humanity and substitute for true human values those of a small and highly institutionalized class.

It is especially unfortunate that the women of this class do not rear moderate-sized families, because they are so widely imitated by the women in other classes.

(To be continued)

THE PHYSIQUE OF THE ANCIENT HAWAIIANS

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THE primitive Hawaiian type is rapidly vanishing. Like many of the island peoples of the Pacific, contact with the white race has wrought far more woe than weal. The Caucasian vices were acquired with much greater facility than were the sober virtues, and a variety of influences, racial and sociologic, have led to the decimation of what was at one time one of the finest peoples in the Pacific Ocean.

It is not the purpose of this paper to delineate the successive stages in the extinction of the ancient Hawaiian, nor to analyze the complex factors that have so rapidly undermined the race, but rather to present a somewhat detailed sketch of the bodily characteristics of the typical native in the prime of his "golden age." The patheticaly rapid shrinkage of the native population may be visualized from the following data. Captain Cook's estimate in 1778, which may have been somewhat, although not greatly, exaggerated, was 400,000. Five decades later, in 1823, the census showed only 142,000. At the close of another decade the native population dropped to 130,000, a shrinkage of 12,000, or at the rate of 100 decrease per month. The next interval of thirty-six years witnessed a frightful decrease of two thirds of the total population, reducing the natives to 44,000. In 1900 there were but 30,000; the past ten years have brought a decrease of over 10,000, and to-day, in 1916, there are probably not 16,000 pure-blooded Hawaiians.

The modern tourist who visits the Hawaiian Islands sees very few of the pure-blooded natives; those in Honolulu, the capital city, are very largely "part-Hawaiians" or hybrids, and a very considerable percentage of the natives residing in outlying districts have foreign blood. The official statement of population as given in the last report of the Governor of Hawaii (1915), records—in round numbers—26,000 native Hawaiians for 1910 and 24,000 for 1915, a decrease of 2,000, or over 7 per cent. in five years. The mongrel or part-Hawaiian population is given as 12,500 for 1910, and 14,800 for 1915, an increase of 2,200, or 18 per cent. for 5 years. It should be emphasized that

a large portion, perhaps thirty per cent., of the natives listed in the above figures as "native Hawaiians" are not in fact, pure-blooded Polynesians, but have varying proportions of mixed blood. The natives have intermarried freely, both in and out of wedlock, with all who came to their shores, since the days of the first explorers, so that to-day it is practically impossible to absolutely determine pure lines of descent.

In striking contrast with the degenerate mixtures that characterize the modern native stand the records of the first explorers as to the splendid and beautiful physique of the primitive Hawaiian. Captain Cook, the first English discoverer of the islands, describes the chief Kane-ena as "one of the finest men I ever saw. He was about six feet high, had regular and expressive features, with lively dark eyes; his carriage was easy, firm, and graceful." Bryan, in his "Natural History of Hawaii," states:

> At the time of the discovery of the Hawaiians they were physically one of the most striking native races in the world . . . as a race they were tall, shapely, and muscular, with good features and kind eyes. In symmetry of form the women have scarcely been surpassed, if equalled, while the men excelled in muscular strength.

Anthropologists agree that the ancient Hawaiian was one of the finest physical types in the Pacific, and compared very favorably with the best types from any other part of the world. They were tall and well developed, with splendidly shaped torsos, and fine muscular limbs of excellent proportions. According to measurements compiled by Topinard, the Hawaiians have greater manual strength than the Micronesians, Australians, Negroes, Iroquois, Chinese, French seamen, or American soldiers, and are only surpassed by the Iroquois in strength of back. The average height was about five feet ten inches, and many of the chiefs were over six feet. A skeleton from one of the ancient burial caves measured six feet seven and three quarters inches, and, as Bryan states, "there is sufficient evidence to establish the fact that men of even larger stature were by no means unusual."

The physique of the chiefs and their families was so superior to that of the common people that some anthropologists have thought them to be of a different tribe or race. The difference is not to be accounted for in this way, however, but rather to the excellent care taken of the children of the nobility, their better food and other conditions of life, and their healthful sports and exercises. The drudgery was done by the common

people and slaves; the chiefs devoted themselves to the development of bodily and mental superiority. Captain King (1778) states:

> Those [chiefs] whom we saw here were, without exception, perfectly well formed; whereas the lower sort, besides their general inferiority, are subject to all the variety of make and figure that is seen in the populace of other countries. They seem to have very few native diseases among them, but many of the chiefs suffer dreadfully from the immoderate use of the awa.

The physical superiority of the chiefs is striking negative evidence against the popular belief in the bad effects of inbreeding. The chieftain class married habitually within itself, very commonly within the same family. Frequently a chief married his own sister, in order that the offspring might have the highest rank. These very close intermarriages were a permanent policy of the Hawaiian nobility during a period of at least many hundred years. There is absolutely no evidence of deterioration of any sort. On the contrary, all who saw the chiefly classes in the early days agree as to their striking bodily and mental superiority.

The color of the Hawaiian was an olive-brown or rich brown, never black nor conspicuously reddish. The common people, who were constantly engaged in fishing, field labor, and the like, were usually darker, through exposure to the weather, than the chiefs and women of rank, who avoided the sun. The variation in hue was considerable, ranging from a light coffee brown to a dark reddish-brown. Occasionally there was a distinct olive tint. After intermingling with Europeans this range of color was, of course, greatly accentuated with the varying degrees of hybridism.

The skin of the healthy, well-kept primitive Hawaiian was by no means unattractive. Coupled with their superb physique it gave them the appearance of "burnished statues" or "bronze Greek gods." It is a matter of common observation among travelers that in the dark-skinned peoples the nude figure does not give the impression of lack of clothing—there is absent that glaring contrast which the white body exhibits when disrobed. When the Hawaiians saw white men for the first time, they thought that the latter were suffering from some serious skin disease.

In the ancient régime the better class of natives kept their skins in excellent condition, through daily baths in the sea and in fresh water, and by oiling the body with coconut oil. The

cheeks of the young men and maidens were rosy, and the skin gave every evidence of abounding vitality.

The chiefs and women of rank kept their skin and bodies in perfect condition through an elaborate system of *lomi-lomi* or massage. The body was stretched at full length on the mats, and the operator (sometimes there were several operators) gave an exceedingly thorough and vigorous massage, not only rubbing, but also kneading, pressing, thumping, pulling, and using a number of other motions peculiar to the art. The noble person receiving the massage would commonly sleep during this highly beneficial performance, which often lasted for several hours.

Many of the chiefs and women of their families have been remarkable, not only for their height, but also for their weight. Four hundred pounds was formerly not unusual for one of this favored class, and three hundred pounds was a prevalent weight among the nobility. This corpulence was much more common among the women that the men, and was due to a variety of factors: (1) A diet consisting very largely of excessively starchy foods, such as *poi*, bananas, sweet potatoes, breadfruit, etc. Meat, chiefly in the form of fish and other marine animals, was a distinctly minor item in the diet. (2) Habitual over-eating. The Hawaiian nobility, like those of medieval European stocks, were often gross feeders. Incredible quantities of food would be consumed at a single meal. Gluttony was the prerogative of aristocracy, very much as was intoxication. (3) An indolent mode of life. As in other aristocracies, all the menial and productive labor was performed by the lower classes; the upper stratum was provided with abundant leisure, which was commonly abused. (4) For the women, obesity was a part of the ideal of feminine beauty, and was cultivated to a gross and grotesque degree.

A distinctive character of the ancient Hawaiian, and of the Polynesian peoples generally, was the ease and grace with which the limbs were habitually moved. The gait of the men and women alike was almost invariably graceful, smooth and dignified. The stately deportment of the chiefs and priests is noted by all the early explorers. The Polynesian mode of walking lacked all of those nervous, jerky motions that are so characteristic of many European peoples. The beautiful muscular development, and the absence of nervous temperament, were alike manifested in the tranquil poise and unhurried gait of the primitive Hawaiian.

In the movements of the arms a similar grace and control

was distinctive. The gestures of the orator or chief were smooth, sweeping, and as impressive and finished as those of a cultivated white man. In the dances the arms played a very important part—many of the "dances" were performed by large numbers of persons *seated*—and were moved with beautiful rhythm. In those dances in which a large company participated the movements of each individual were coordinated with extraordinarily precise harmony with those of the others, a rhythmic precision far more accurate than that, for example, of the modern Occidental ballét.

Tatuing has become wholly extinct. The art itself is forgotten, and there are now no tatued natives, nor have there been for many years. The Hawaiian never developed systems and patterns of tatu as elaborate as those of his South Sea Island congeners, the Samoans and the Maoris. It is entirely probable that the primitive Polynesians who were the first discoverers of the Hawaiian Islands, and the progenitors of the Hawaiian people, left the South Pacific dispersal center, Samoa, before the art of tatuing had evolved to its final, highly elaborate designs. However that may be, the Hawaiians at the time of the discovery by Europeans, were very sparingly tatued. Tatuing appears to have been more prevalent on Kauai than on the other islands of the group. It should be noted that the Kauaians were distinguished from the natives of the other islands by a number of archaic traits and customs.

The Hawaiians had neither the complicated thigh- and hip-tatuing of the Samoan, nor the ferocious facial tatuing of the Maori. The art was confined largely to the males, and so far as the records show, was a prerogative of rank. Unlike the Maori and Samoan women, the Hawaiian females do not appear to have used the tatu, save for a curious custom which Captain King records as follows:

> The custom of tattooing the body they [the natives] have in common with the rest of the natives of the South Sea islands, but it is only at New Zealand and the Sandwich Islands that they tattoo the face. They have a singular custom amongst them, the meaning of which we could never learn —that of tattooing the tip of the tongue of the females.[1]

Upon contact with Europeans the natives abandoned their own modes of tatuing, and thus the records are very scanty. The available evidence, however, indicates that the patterns were much coarser and inartistic than those of the Samoans. In many instances the markings were limited to a few spots on

[1] The women also sometimes had the back of the hand marked with a pattern somewhat similar to that of an open-work glove.

face, near the eyes or mouth. One famous chief, Ka-hekili, had one side of his body, from head to foot, tatued, so that he appeared half brown and half black, a pattern like a jester's costume.[2]

There are no records indicating special symbolic significance to the patterns, like those of the Bornean head-hunters. The lowest class in the Hawaiian social system—the slaves or *kauwa*—usually captives of war, were marked or branded on the forehead, but this seems to have been distinct from the tatu, and was regarded as a sign of infamy or disgrace. The opprobrious epithets, *lae-puni* and *maka-wela*, which were applied to the slaves, have reference to the brand or mark.

The Hawaiian head was well formed, and closely resembled that of the best European types in contour and proportions. It rarely exhibited the deformities which characterize the skulls of many primitive peoples. The skull was sub-brachycephalic or "mesaticephalic" in type. The cephalic indices of a large number of living "specimens" averaged 82.6. Those of an extensive series of skulls average 79.0, with a minimum of 75.0. This range is similar to that found among the Chinese people. The Hawaiian skull was never prognathous. Broca found among the Hawaiians the highest orbital index that he had ever observed. The jaws were of good proportions, resembling those of European types, with well-formed chin and cheeks. Projecting or noticeably receding jaws were rare.

The hair was black or dark brown. It was straight, slightly wavy, or curly; never frizzy or kinky like that of the negro or Papuan, nor lank like that of the Malayan. It was strong, and usually of rather coarse texture; very fine texture was rare. Old age brought gray or white hair; baldness was very exceptional. The hair of the women was long, but no unusual lengths are recorded. There is no evidence to show that very long hair was looked upon as a special attribute of feminine beauty. Alexander states that "it was the fashion among the women to wear the hair short in front and on the sides of the head, and to turn up the edges on the forehead and temples with a wash made of lime or white clay." The custom of heavily liming the hair was not practised in the Hawaiian Islands as commonly as in the South Pacific. The hair of the men was cut in a variety of peculiar styles, sometimes with a mane-like crest over the center of the crown, sometimes with long locks reaching down toward the shoulders. The beard of the men was thin and

[2] Tatuing was sometimes done as a token of mourning at the death of a friend or chief.

sparse, and restricted chiefly to the chin and lips. In many instances it was plucked out, as was the hair on the legs and arms. The typical native man was smooth, and the chest was usually lacking in the hairy growth characteristic of many Europeans. Captain King states:

> The same variety in the manner of wearing the hair is also observable here as among the other islanders of the South Seas; besides which they have a fashion, as far as we know, peculiar to themselves. They cut it close on each side of the head down to the ears.

The face was moderately broad, with a kindly, open countenance, and features quite regular and often beautiful. The young people of both sexes were, with few exceptions, good looking, and the girls were often of striking and voluptuous beauty. Captain King writes:

> Many of both sexes had fine open countenances, and the women in particular had good eyes and teeth, and a sweetness and sensibility of look, which rendered them very engaging.

Bryan states:

> In general, their features were strong, good humored, and in many instances, when combined with their splendid physiques, produced a striking and impressive personality that gave the impression of their belonging to a very superior race.

The profile was regular, not prominent, and usually pleasing. In many instances it closely resembled the profiles of the higher Caucasian types.

The nose was of good length, well shaped and arched. Frequently it was somewhat flattened, due to artificial pressure and massage in infancy, as a flattened nose was esteemed much more highly than a pointed or protruding one. The practice of massaging the newly-born babes, especially those of the nobility, was general and elaborate, and was supposed to greatly influence the future beauty of the child. For example, the outer angles of the elbows, particularly of the girls, were vigorously massaged, as a sharply pointed or angular elbow was looked upon as a very ugly characteristic.

The eyes were large, well formed, and expressive. Until European mixtures were introduced they were invariably black. Occasionaly the eyes were a trifle oblique, but this character was comparatively rare, and apparently of no anthropologic significance. The lashes and eyebrows were black, well-formed, and often quite long. Many of the younger women had beau-

tiful eyes. As indicators of character the Hawaiian's eyes were typically kind, cheerful, mild and generous. The crafty, cruel, bloodthirsty, and lustful types occurred, of course, as they do in any human society, but under ordinary conditions they were distinctly in the minority, and did not represent the normal Hawaiian life. The eyes of the ancient Hawaiian chief of good character were as fine and expressive as those of a high-grade European. Those of many of the women were notably bright, clear, and attractive. The ability of the primitive Hawaiian as a sailor and a woodsman indicates that the power of vision was well developed, although not to any remarkable degree. There is no indication that he possessed the keenness of vision customarily ascribed to such peoples as the American Indian and the Australian aborigine.

The Hawaiian mouth was well formed. The lips were usually of medium thickness, frequently voluptuosuly thick and everted; rarely thin. The upper lip was usually a trifle shorter than the lower, giving to the mouth a peculiar, not unpleasant, and easily recognizable, racial form. The thick lips, particularly of the younger women, were well molded and attractive. Like the eyes, the mouth was typically indicative of kindness, mildness, and generosity. The tight, pursed, narrow mouth was very rare.

The teeth were excellent in shape and arrangement, and of a glistening pearly whiteness. The beautiful teeth of both the men and the women are frequently mentioned by the early explorers. The beauty was often defaced by a curious custom of knocking out one or more of the front teeth as a token of grief upon the death of some friend or chief; in many instances the middle-aged and older people would lack many of the front teeth, both upper and lower, as a result of this senseless custom.

It is not the purpose of this paper to exaggerate the physical excellences of the primitive Hawaiian, nor to give the impression that splendid manly physique and sensuous feminine beauty were universal. As in all human communities, Hawaii also had the ugly, the maimed, the dwarfed, the diseased, the weaklings. Many of the older women were veritable hags; many of the older men were disfigured by dissipation or by drudgery. Captain Cook described a chief named Koa, who "was a priest, and had been in his youth a distinguished warrior. He was a little old man, of an emaciated figure; his eyes exceedingly sore and red, and his body covered with a white leprous scurf, the effects of an immoderate use of the awa." In general, however, the people seemed to be remarkably free from disease or bodily disfigure-

ment; it was not until the vile venereal diseases of the white sailors and traders began to spread among the people, that deterioration set in. These and other Caucasian diseases, the inordinate use of the liquors plentifully supplied by the white man, and a variety of other debasing influences undermined the constitution of the people with astonishing speed; thus the primitive Hawaiian, with fine physical and mental traits of the greatest promise, is disappearing, and in a few years will have vanished forever.

RILLY, A FOSSIL LAKE

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THE science of paleontology may be as dry as dust or as interesting as a masterpiece of fiction according to the degree to which its devotees grasp its principles and ideals. All are doubtless inspired by the wish to contribute toward the completion of the geologic record and to elucidate the phylogenies of the animal and plant kingdoms. This most exact and painstaking work undoubtedly forms both the foundation and superstructure of the paleontological temple of science, but, until it becomes open to the devotees of the other earth sciences and to the general public, inspiration and achievement are limited to a small circle of the elect and the temple remains without liturgy or ceremonial.

Fossil floras and faunas are not interesting chiefly as medals of creation, but as the objective evidence of the marvelous living and moving life of the sea, earth and air of bygone days. They record the dynamic and epic history of the struggle for existence during countless ages and furnish the data for what Huxley aptly termed retrospective prophecy—the restoration of the past. We desire to know the progressive changes in the continental outlines; when the invasions of the land by the sea occurred; the kinds of life and how they lived; the depths and temperatures of the waters—whether clear or muddy, brackish or fresh; whether the aquatic forms were inhabitants of lakes, streams, lagoons or seas; whether the land animals and plants were those of forested glades, stream banks, plains or sea shores.

Such questions we ask of fossil floras and faunas and while the reliability of the answers depends upon our exact knowledge of both recent and fossil forms of life and their environments, systematic paleontology is only the means toward these ends.

Some sixty miles directly east of Paris on the western border of the Champagne country—the Campi Catalaunici of the ancients—lies the little town of Sézanne, long celebrated in the annals of paleobotany for the marvelous preservation of lower Eocene plants in travertines. These exposures of traver-

tine, notably La Butte-aux-Grottes southwest of the village, early excited the interest of geologists and we find the deposits described[1] as early as 1842. The travertine is of various kinds —sometimes massive, sometimes irregularly laminated and elsewhere porous and full of minute galleries. Langeron[2] and others have shown that while the more massive deposits may be formed by evaporating waters, the most active agents in its formation were colonies of minute freshwater algæ of the families Nostocaceæ, Oscillatoriaceæ and Chlorophyceæ. The metabolism of these algal colonies caused the soluble bicarbonate of calcium to lose its second molecule of carbonic acid, the insoluble neutral carbonate being thus thrown down from solution and deposited. The travertine thus deposited in the interstices of these algal colonies has a porous structure and the abundance of the larvæ of various dipterous insects in such algal mats readily explains the tiny galleries that traverse the travertine and thus lead us to the conclusion that various midges and gnats danced in the sunshine of the Sézanne woods.

Fossil plants were described[3] from these travertines as early as 1842 and Brongniart[4] enumerated a Marchantites and two ferns from this locality. Watelet[5] added an alder, a beech and one or two other species in 1866, but it remained for Saporta[6] to do full justice to the richness of this deposit, his results appearing in 1868. The late Munier-Chalmas, with characteristic painstaking efforts, devoted much time to making wax casts of the flowers, fruits, seeds and insects preserved at Sézanne and his wonderful collection is now at the Sorbonne. So far as I know he published no descriptions of these objects and except for a fine paper on the flowers, fruits and seeds of Sezannella, a genus of Sterculiaceæ, by Viguier[7] in 1908, they remain undescribed. Langeron[8] has published several short papers on the mode of origin of the travertine and on additional

[1] Duval and Meillet, "Coupe des terrains des environs de Sézanne," *Bull. Soc. géol. France*, 1 ser., tome 14, pp. 100–104, 1842.

[2] Langeron, M., *Soc. Hist. Nat. d'Autun*, 1899.

[3] DeWegmann, *Bul. Soc. géol. Fr.*, 1 ser., tome 14, pp. 70–71, 1842.

[4] Brongniart, A., "Tableau," p. 115, 1849.

[5] Watelet, Ad., "Description des plantes fossiles du bassin de Paris," 1866.

[6] Saporta, Gaston de, *Mém. Soc. géol. France*, 2d ser., tome 8, pp. 289–436, pl. 22–36, 1868.

[7] Viguier, R., *Revue gén. Botanique*, tome 20, pp. 6–13, Figs. 1–6, pl. 5, 1908.

[8] Langeron, M., *Bull. Soc. Hist. Nat. Autun*, tome 12, pp. 431–455, 1899; tome 13, pp. 333–370, 1900. *Bull. Mus. d'Hist. Nat.*, Paris, tome 5, pp. 104–106, 1899: *Idem.*, tome 6, pp. 318–320, 1900.

forms of plants, so that the described flora now numbers about 100 species and many more await description.

Sézanne lies near the western limit of the Champagne country, where the somewhat monotonous vineyard clad chalk plain disappears beneath the escarpment of the Tertiary plateau of the Île de France. It is situated in the Department of the Marne which belongs in part to the Archbishopric of Reims, founded in the third century, and partly to the See of Châlons. Reims, the capital city of the Remi and where the kings of France were crowned, is only about 40 miles to the northward. About 30 miles northeast of Sézanne is Châlons, near which 1,466 years ago (A.D. 451) Attila, the most powerful heathen king that ever ruled in Europe gathered together the Huns of the fifth century after reverses on the Loire and was finally defeated by the soldiers of Aëtius and his Gothic allies in what was the last great victory of Imperial Rome and the first great battle of the Marne. The second great battle of the Marne is fresh in our memories and in its decisive results and in the character and ambitions of the contestants it is in many ways comparable to the battle of Châlons.

A small tributary of the Aube rising in the hills that mark the escarpment of the Tertiary plateau and the chalk plain of the Champagne flows to the southeastward by Sézanne.

During the Upper Cretaceous a shallow sea of Atlantic origin invaded the Paris Basin. The prevailing sediments of this sea were earthy limestones commonly known as chalk, and this Upper Cretaceous chalk now outcrops in a broad ring or aureole around Paris, its inner margin lying from 30 to 100 miles distant. The chalk underlies all the later deposits in the center of the Basin. Its characteristic weathering results in the formation of a more or less treeless plains type of country, such as the plains of the Champagne on the east, of Picardy on the north, of upper Normandy, Maine and Touraine on the northwest and west. This chalk country extends from Bourges northeastward past Troyes and Châlons. At Reims it swings to the west past Vervins. At St. Quentin it turns again to the south past Amiens, Beauvais, Rouen, Chartres, Blois and Tours to Châteauroux. This is a country of ancient as well as modern greatness and the very names carry us back through eventful human history to the days of Cæsar's campaigns. The relics found in the valleys of the Somme and the Seine carry us back still farther to the men of the old stone age, some 10,000 years before Cæsar's time, and the fossil shells that we dig out of the chalk and that represent the inhabitants of this Upper Creta-

ceous sea carry us back some three or four millions of years earlier to a time when man was not even a promise and the dinosaurs were the lords of creation. During its maximum extent this Upper Cretaceous sea covered most of France—the only emerged areas being the massifs of the Ardennes, Bretagne, Cantal and Savoie. The Paris Basin was connected with the Mediterranean along the Rhone valley and with the Bay of Biscay across the lower valley of the Loire. Europe was an archipelago at this time, the Scandinavian and Russian shields being the only large and continuous land masses. This Cretaceous sea eventually commenced to shrink and by slow stages nearly all of the Paris Basin emerged from beneath its waters. Not to dwell upon the events of the closing days of the Cretaceous, which is foreign to my present purpose, it may be noted that while the shallow epicontinental seas lingered longer in some regions than in others, as, for example, in Denmark and North Germany, this was a time of littoral and continental deposits.

The length of time during which the land was emerged varies for different localities, and while we have no measure of this interval it must have been very long, judging by the changes in the life that we observe in the earliest Eocene seas. The Cretaceous seas swarmed with specialized cephalopods known as ammonites. Thousands of species are known and not one survives in Eocene times. The changes in the other forms of marine life, while not so spectacular, are equally marked. For example, in the earliest Eocene sea of southeastern North America, known as the Midway sea, we find an entirely different fauna from that found in the Cretaceous beds lying immediately beneath these Eocene deposits. This change in the life of successive deposits in this region is greater than has taken place in all the time that has elapsed between the Midway and the present. Equally great changes mark the earliest Eocene terrestrial faunas and floras. For example, about 350 species of plants are known from the lower Eocene of southeastern North America and not one of these plants has been found in the Upper Cretaceous anywhere. We are in an apparently new world in Eocene times and, if these changes in the life are an accurate measure of the time involved, it would seem that the seas were absent from the present land surface several millions of years and that the continental outline of Europe during this interval foreshadowed its modern outline.

The earliest Eocene sea in the Franco-Belgian Basin is named the Montian sea from deposits of this age around Mons

in Belgium. The Montian sea was limited in its extent and fell far short of reaching south as far as Sézanne. The first well-known Eocene sea in this region whose sediments are mapable over wide areas is named the Thanetian sea (from the Isle of Thanet in the London Basin) or Landenian sea (from Landen east of Bruxelles in Belgium). Between Sézanne and Reims a considerable area is occupied by the marls and limestones of Rilly, named from a little town of that name south of Reims. These are freshwater limestones and marls that were deposited in a large lake or series of ponds, as is indicated by the variety and numbers of shells of pond snails found fossil in these deposits. Nearly fifty different kinds are known and these include some land snails. Some of the genera are *Physa, Valvata, Planorbis, Succinea, Pupa, Helix,* etc., and they are said to resemble modern forms of the Antilles and South America. In the lakes and rivers were fish of various kinds including the curious mud-fishes (*Amia*) and swarms of gar pikes (*Lepidosteus*), both now confined to North America. Turtles of several varieties (*Chelonia, Trionyx, Emys*) were abundant and salamanders have also been found. Crocodiles basked on the banks or hunted in the waters and these included both the Nile type of crocodile and the long-snouted Ganges type or gavial.

The shores were densely wooded with broad-leafed warm-temperature types of trees, and for these the travertines found at the little butte southwest of Sézanne will give us the best picture of the contemporaneous plant life, although a similar glade flora is found near Louvois, in the sandstone of Vervin and in the marls (Heersian) of Gelinden on the road to Liège.

At Sézanne we can almost reconstruct the whole picture. A swift-flowing stream, as shown by its pebbly bed, cascaded from a low chalk escarpment into a damp wooded ravine which opened into the Rilly lake. Mosses (*Fontinalis*) and stoneworts (*Chara*) sheltered the crayfish (*Astacus*). Moisture-loving plants like the two *Marchantites,* and a variety of ferns (*Asplenium, Blechnum, Adiantum,* etc.) covered the stream banks which were overhung by figs and laurels, magnolias, walnuts, maples and a host of tree types since become extinct or no longer found in Europe. Insects and even such delicate objects as flowers are faithfully preserved in the travertine. Among the most interesting of these are those named *Sezannella* by Viguier and shown in the accompanying illustration (Fig. 1). They belong to the tribe Lasiopetaleæ of the tropical family Sterculiaceæ and are related to existing

forms of the American tropics. The illustration shows a flower with two of the petaloid sepals removed, disclosing the large central superior ovary surrounded by the closely appressed stamens opening at the tips of the anthers and each opposite a reduced scale representing the vestigial petals. The second figure shows the five-valved tardily dehiscent capsule or fruit of *Sezannella*, also found abundantly in the travertine. Both are shown natural size.

Altogether twelve species of ferns have been found at Sézanne, and these include several of the tree fern genera *Alsophila* and *Cyatheites*, eloquent witnesses of the humid climate. There are two palm-like forms referred to the genus *Ludoviopsis* from their resemblance to the curious genus *Ludovia* of the tropical South American Cyclanthaceæ. An entirely extinct genus is *Dryophyllum* with four species in the

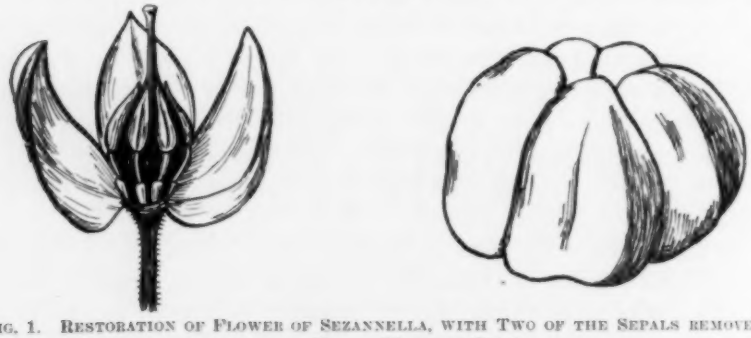


FIG. 1. RESTORATION OF FLOWER OF SEZANNELLA, WITH TWO OF THE SEPALS REMOVED, AND OF A FRUIT (NATURAL SIZE).

Sézanne woods. *Dryophyllum* was very common along the borders of the lower Eocene sea both in Europe and America, and is considered to represent the ancestral stock from which both the oaks and the chestnuts were derived. Ten different species of laurel have been found at Sézanne and these include a sassafras. The latter was a varied and common type throughout the Northern Hemisphere during Tertiary times, but is now confined to North America, where its single species is one of the very few plants of the great family of laurels (Lauraceæ) that has survived at any great distance from the equatorial region.

The Sézanne flora contained seven aralias, which are mostly American tropical types in modern floras, although common throughout the Holarctic region during the Upper Cretaceous and earlier Tertiary. Magnolia is another Sézanne type that is no longer found in Europe, but is now confined to southeastern

North America and southeastern Asia. There were six species of *Grewiopsis* at Sézanne which Count Saporta compared with existing Brazilian species of *Luhea*. Some of the more familiar Sézanne types were bayberries or swamp myrtle, alders, birches, elms, cottonwoods, maples, willows, sheep berries, buckthorn and cornel. There were two species of *Zizyphus*, a genus which in the existing flora comprises about two score scrambling shrubs or small trees mostly confined to the Indo-malayan tropics, but with a few species in all tropical countries. In the past *Zizyphus* was cosmopolitan, with very many now extinct species. Some distance north of Sézanne are found white seashore sands (*sables blancs siliceux de Rilly*) with the remains of marine molluscs. These are overlain by the *gravier marin de Cernay*. A few of the land animals that roamed in the Sézanne woods have been discovered around Reims in the latter beds and constitute the so-called Cernaysian fauna of the late Victor Lemoine—the oldest known European Eocene vertebrate fauna. The *gravier marin de Cernay* (Cernay is a little town about three miles east of Reims on the western slopes of the Mont-de-Berru) are seashore and river channel gravels containing sharks' teeth and molluscan shells of mixed marine and estuary forms. Scattered bones represent the land animals that were accidentally drowned or whose dead carcasses were swept down the streams into the estuaries and coastal lagoons. These give us a welcome glimpse of the terrestrial animal life of these early times. They comprise small insectivores, lemur like forms, small gnawing marsupials, numerous primitive carnivores and a few primitive hoofed animals—an assemblage much like that found in the Puerco beds of New Mexico and of similar age. Without dwelling at length on this point, enough has been said to suggest that in these earliest Eocene times the plants and animals of the whole Northern Hemisphere or Holarctic region were much alike and were able to migrate freely from Europe and Asia to and from North America. That Holarctica was a single botanical and zoological province during the early Eocene has long been the conclusion of paleobotanists and vertebrate paleontologists. This does not mean that either the floras or faunas were monotonously uniform throughout this vast region. Some of the types of plants and animals became cosmopolitan, others never did. There were always local assemblages of forest, shore and plains forms. The warm glade floras and faunas of the south as at Sézanne or in the strand flora along the expanded Gulf of Mexico were markedly different from the contemporaneous

plains floras and faunas of more arid regions such as was so much of the western United States during the Eocene.

The succession of events along the shores of the expanding and subsequently shrinking Thanetian sea are clearly indicated in the shifting sediments and their contained fossils. This history is too complex in its details for popular presentation. At one point we recognize seashore sands; at another estuary muds, forming lenses of clay; channel or delta sands and grav-

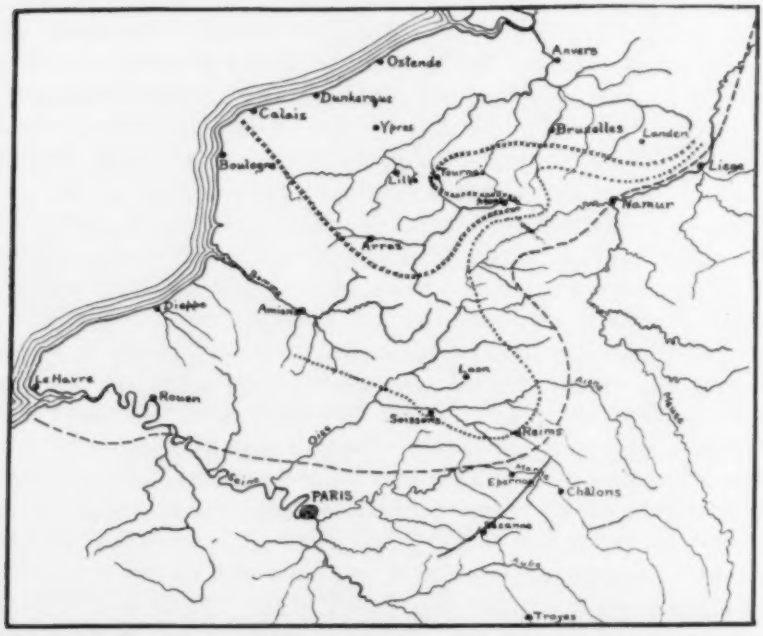


FIG. 2. SKETCH MAP OF A PART OF FRANCO-BELGIAN BASIN SHOWING PROGRESSIVE SUBMERGENCE OF THE LOWER EOCENE.

× × × × × Landward limit of distribution of *Cyprina morrisi* of the early Thanetian sea.

. . . . . Landward limit of distribution of *Pholadomya konicki* of the middle Thanetian sea.

– – – – – Landward limit of distribution of *Cyprina scutellaria* of the later Thanetian sea.

——— Landward limit of the lagoons of the Thanetian sea during its maximum extent.

els occur in places; elsewhere we recognize that we are dealing with beach shingle; lenticular clay beds are seen to represent mud deposits in coastal lagoons; and dune sands are recognizable, as, for example, the *sables d'Ostricourt*, now outcropping from Bethune southeastward to Vervins, and largely made up of fossil sand dunes that followed the retreating strand line, and which contain in places the traces of vegetation appro-

priate to such an environment, as at Artres, Proix and Lewarde.[9]

The accompanying sketch map (Fig. 2), based very largely upon the excellent studies of M. Leriche, illustrates the varying history of the Thanetian sea. The Rilly lake or lakes occupied approximately the area of the rough triangle formed by Sézanne, Châlons and Reims. It is not possible to indicate its outline since its deposits merge in the seashore sands and overlying marine beds that subsequently transgressed it from the north. The sinuous line of small crosses extending from South of Landen and Bruxelles through Tournai and near Mons, Arras and Calais marks the landward limit of distribution of *Cyprina morrisi*, a characteristic mollusc commonly found in the sands of the earliest and most restricted Thanetian sea. As this sea continued gradually to increase in size its shores came to occupy the position of the sinuous dotted line running through Reims and Soissons which marks the landward limit of distribution of glauconitic sands with oyster beds and other marine molluscs and characterized by the species *Pholadomya konicki*. The Thanetian sea continued to grow in size and the somewhat glauconitic but often bleached and consolidated sands of this period in its history, which are characterized by *Cyprina lunulata*, but especially by *Cyprina scutellaria*, mark its maximum limits. The broken line of the map that extends through Liège and Namur, east of Reims, swinging westward near Epernay and continuing westward north of Paris and south of Rouen to the present coast near Le Havre, shows the landward limit of distribution of *Cyprina scutellaria* and consequently the minimum limit of the open Thanetian sea at its maximum stage. These sands (*sables de Bracheux, sables de Châlons sur Vesle*) pass imperceptibly into the non-marine shore sands of Ostricourt. The solid line on the map running northeast and southwest through Sézanne marks the landward limit of the lagoons along the low coast of the Thanetian sea at its maximum stage of water.

The sea did not stay at this height for any long period of time, geologically speaking, and as it slowly withdrew to the northward, we find these sands overlain with the sand of dunes and of successive beaches marking the various stages of its shores during their retreat to the northward. These sands are interspersed with beds of lignite representing a succession of palustrine or marsh deposits that were formed in the bayous

[9] Gosselet, J., "Quelques remarques sur la flore des sables d'Ostricourt," *Ann. Soc. géol. du Nord*, tome 10, pp. 100–106, pl. 5, 1883.

of the sluggish rivers or behind successive barrier beaches, and these lignites are interspersed with the plastic clay deposits so common over a wide area in the Paris Basin recording the finer muds contemporaneous with the sands and lignites and deposited in bayous, estuaries, impounded stream-mouths and coastal lagoons. This series of deposits, which are prevailingly clays and lignites, and which overlie the marine sands of the Thanetian, commenced to form at the south while the marine deposits were still being laid down a slight distance farther north, and they are younger and younger as they followed the gradually diminishing sea in its course to the northward. These clays and lignites contain many representatives of the

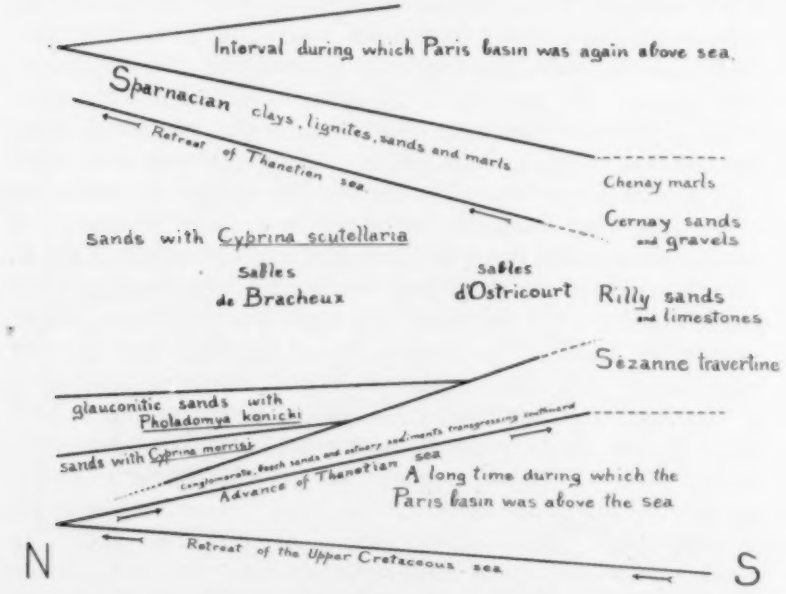
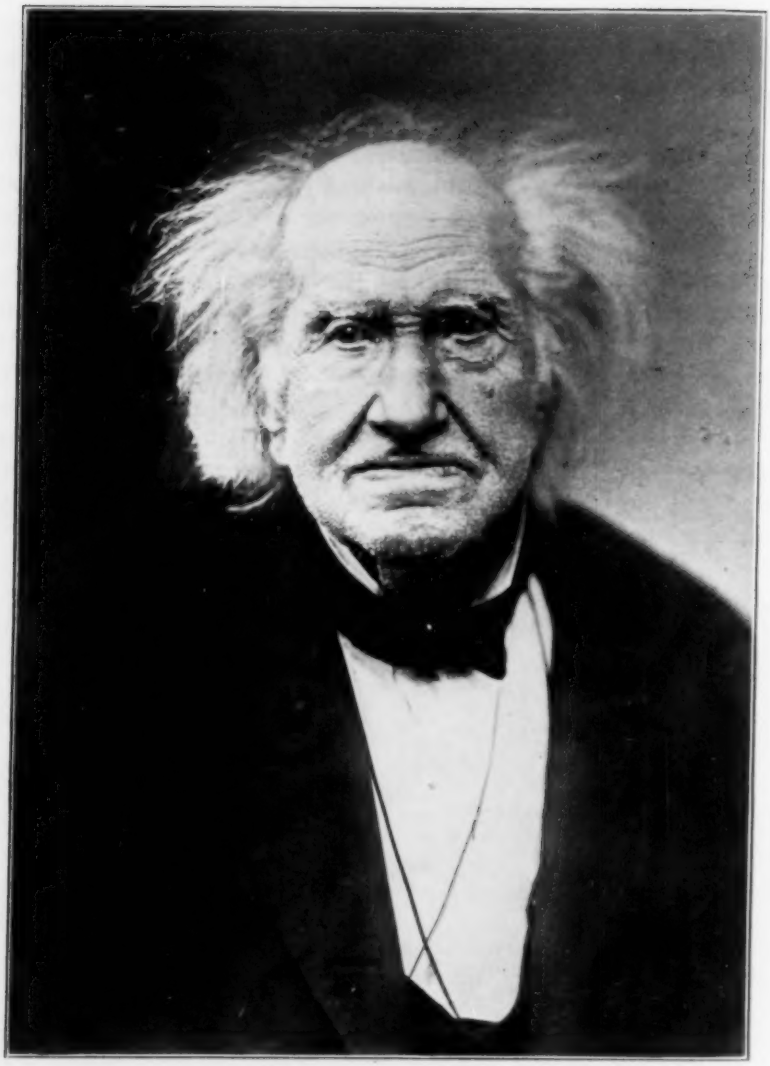

Interval during which Paris basin was again above sea
Sparnacian clays, lignites, sands and marls
Retreat of Thanetian sea
Chenay marls
Cernay sands and gravels
sands with Cybrina scutellaria
sables de Bracheux
sables d'Ostricourt
Rilly sands and limestones
Sézanne travertine
glauconitic sands with Pholadomya konichi
sands with Cybrina morrisi
conglomerate, beach sands and estuary sediments transgressing southward
Advance of Thanetian sea
A long time during which the Paris basin was above the sea
Retreat of the Upper Cretaceous sea
N
S

FIG. 3. DIAGRAM SHOWING THE MIGRATION OF THE STRAND, THE STRATIGRAPHIC HISTORY AND THE BLENDING OF MARINE AND CONTINENTAL DEPOSITS DURING THE THANETIAN STAGE OF THE EOCENE.

land animals and plants of the times and because of this fact and the prevailing lithologic character of the deposits, namely, clay and lignite as opposed to the underlying sands, they have usually been segregated as a separate stage under the name Sparnacian, although they really represent the last or prevailingly continental deposits of the Thanetian cycle of submergence. Hence some authors group them as a substage with the Thanetian marine sediments and call the larger unit the Landenian stage. A period of emergence during which the Paris Basin was again dry land followed the Sparnacian.

The geological history thus briefly sketched is represented by the diagram shown in Fig. 3, which summarizes the advance and retreat of the Thanetian sea and shows some of the characteristic deposits accompanying these changes, and their relation to the deposits forming at the same time on the land, in the stream at Sézanne and in the Lake of Rilly. Thus what in the first survey of the areal geologist seemed like an unintelligible tangle of sands, clays, limestones and gravels, becomes resolved into an orderly sequence—of great variability, to be sure—but capable of being separated into its component units, each with its page of physical and organic history.

After the facts have been patiently and accurately accumulated in any area it becomes possible to restore the geographic outline of the continent, the confines of salt and brackish waters, the rivers and lakes, the forests, meadows and swamps, and the life that teemed in all of these environments. The successive shifting scenes can often be more readily deciphered than can we understand the gradual changes that are taking place in our own environment at the present time.



MICHAEL EUGENE CHEVREUL.

The distinguished French chemist, long professor of organic chemistry and director of the Paris Museum of Natural History, retiring from the directorship at the age of ninety-three years, though still continuing his professorship. Chevreul's scientific work covers a wide range, but he is best known for his researches on animal fats. Chevreul died in his hundred and third year, the photograph here reproduced having been taken when he was a hundred years of age.

THE PROGRESS OF SCIENCE

CHEMISTS AND NATIONAL SERVICE

THE recent report of a committee of chemists to the Council of National Defense embodies a plan for the training and conservation of chemists and for the utilization of their knowledge and skill in the service of the government. The experience of the other belligerents has shown the wisdom of such foresight. England, France and Italy found it necessary to recall all chemists from the ranks, Canada does not allow them to enlist, and careful observers have insisted that Germany has been saved thus far in large measure through its chemists and other scientific men.

The committee of chemists pointed out the present shortage of trained men in that science, which is becoming more acute through the demands of war conditions. It requires from four to seven years to train a chemist, the longer period being required by those equipping themselves for the doctorate, on whom will fall the vast needs of the government and industries for solving new and difficult problems of research. When the more mature chemists are called into the service of the government, younger men must be trained to fill the vacant positions. The committee of chemists therefore decided that: "It is of greatest importance that steps be taken: (1) To keep and impress into service in chemical lines chemists drawn by the draft for service in the United States Army or Navy. (2) To provide means for keeping open sources of supply of chemists from universities, colleges and schools of technology and to procure volunteers in chemistry."

The plan proposed to attain these ends provides for a committee of three, preferably one industrial chemist, one university professor and one government representative, to advise the President through the War Department on requests for exemptions. Requests for exemptions of individual chemists are to be made to this committee by government, state or municipal laboratories, and heads of manufacturing plants on the basis of the imperative need of these men, or by the presidents of universities, colleges and schools on the basis of the proficiency, promise and ability of students seeking degrees in chemistry. Only students who will receive their doctor's degree by 26 or their bachelor's degree by 23 years of age should be considered for exemption. Chemists under 21 or over 30 years of age, or those between these ages who have not been drafted may enlist as volunteers in chemistry, subject to the same conditions as the enlisted and exempted men. Students under 21 years of age may enroll in a "chemical reserve," subject to the same conditions as obtained for other government reserves. Men thus enrolled shall be subject to the orders of the government as to the location and nature of their service, and, following the practise of France, shall be entitled to wear a badge or other insignia indicating their official status.

Similar recommendations have been made by other committees representing other sciences in their endeavor to place the knowledge, skill and resources of scientific men at the disposal of the government for war service. The representatives of

other sciences have recommended the conservation of the younger men of science by drafting them into scientific service rather than into the army or navy, and have pointed out the importance of abundant provision for the training of additional men of science. Scientific knowledge offers no special resistance to bullets, but when applied to artillery, munitions, transportation, food products or sanitation, it may be the means of saving thousands of lives and millions of dollars.

THE INFANT DEATH RATE AND SOCIAL CONDITIONS

Low wages of fathers and the gainful employment of mothers away from home accompany an excessive death rate among babies in Manchester, N. H., according to the report on infant mortality in that city which has been issued by the Children's Bureau of the U. S. Department of Labor.

The study was based primarily on interviews with the babies' mothers. It was absolutely democratic in scope and included all babies whose births were registered during a single year and whose families could be found. Of all the babies studied, one in six—165 per 1,000—had died during the first year of life. There were wide variations in rate between different groups of the population, according to the fathers' earnings, the employment of the mother, the congestion of the home, and the way in which the baby had been fed.

Nearly half of the 1,643 babies had fathers whose earnings were less than $650 a year, and more than one eighth of the babies had fathers earning less than $450 a year. Only one in sixteen (6.4 per cent.) had fathers earning as much as $1,250. The death rate among the babies in the poorest families was more than four times as high as among those in the highest wage group.

Low earnings on the part of the father appear to be the most potent reason for the mother's going to work. Where the fathers earned less than $450 a year almost three fourths of the mothers were gainfully employed during some part of the year after the baby's birth. As the fathers' earnings rise, the proportion of working mothers falls, until in the group where fathers earned $1,050 or over, less than one tenth of the mothers worked.

Keeping lodgers was the chief occupation of those who worked at home, and working in the textile mills was the chief occupation of those who worked away from home. The mothers of 267 babies went out to work during the first year of the baby's life, and these babies had a death rate considerably higher than those whose mothers worked at home, or were not gainfully employed. The rate is especially high —277.3 per 1,000—among the 119 babies whose mothers went out to work before they were four months old.

The babies were grouped also according to the kind of house in which the family lived. The death rate for babies whose homes were in one-family houses was 86.1 per 1,000; in houses containing seven or more families 236.6 per 1,000. Similarly the rate showed a steady increase according to the number of persons per room. It was 123.3 per 1,000 where the family had more rooms than persons; and 245.9 where there were two or more persons per room.

THE SAN SALVADOR EARTHQUAKE

Dr. Herbert J. Spinden, assistant curator of anthropology of the

A Wrecked House in San Salvador.

A Ruin of the San Salvador Earthquake.

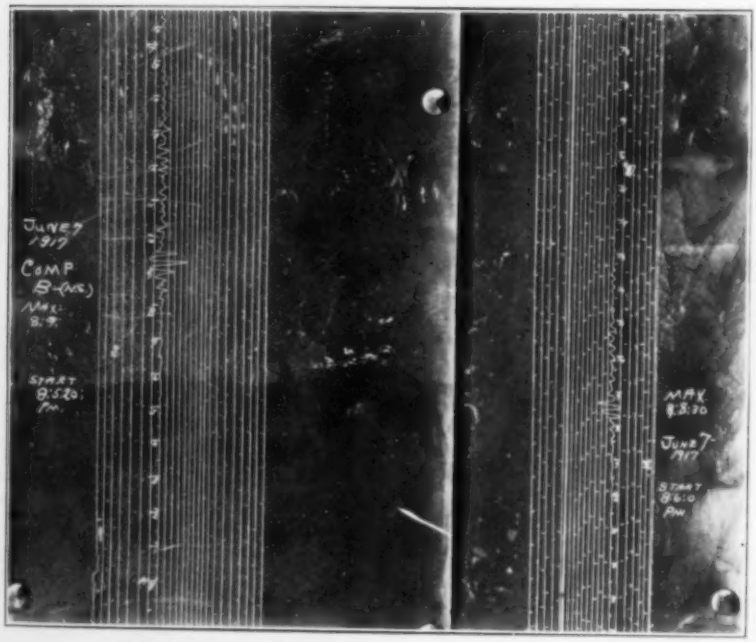
"THE FALLING ANGEL," Parque de Duevos, San Salvador.

American Museum of Natural History, in a recent letter to Mr. George H. Sherwood, assistant secretary of the museum, gives an account of the earthquake in San Salvador which occurred on June 7. Dr. Spinden was at the time in Central America engaged in studying and collecting patterns and materials for textiles useful to American manufacturers.

The first shock occurred between 6:45 and 7 p. m. on June 7, and was recorded in New York by the seismograph in the American Museum. Dr. Spinden reports that several shocks followed the initial one which, coupled with the outbreak of the Salvador volcano, brought terror among the population who crowded from their crumbling homes into the streets and parks of the darkened city. The shocks were not confined to the first day, but continued at intervals with a gradual, though irregular, decrease in intensity for more than a week. Nearly every hour brought a slight tremor, while more violent shocks occurred on June 8, at 10:22 p. m.; on June 9, at 1:00 a. m., and on June 13, at 10:30 p. m. The usual course of a shock was characterized by a rapid rise to maximum intensity, followed

by a gradual decrease or by a series of disconnected tremors, decreasing in violence by slow but frequently irregular degrees. Often, a second shock, called the "echo," followed after a few minutes.

The inhabited regions about the base of the volcano suffered partial destruction, the capital, San Salvador, being particularly unfortunate. Ninety per cent. of the homes were destroyed or rendered unfit for habitation. In many cases the greatest damage was due to the falling of the heavy tile roofs through the inadequate supporting structure. Most of the public edifices, more substantially constructed, suffered but little. Reinforced cement construction stood the test well, while the lighter types of cement crumbled to earth under the strain. The illustrations, sent by Dr. Spinden to the American Museum and here reproduced, show the extent of the damage. The natives, left homeless, have fitted up temporary shelters of mats, burlap and sheets of rusty tin but with the rainy season approaching, a serious situation may result, unless substantial relief from outside sources is received. The food situation has not been critical since the conveyances of some 25,000 people who fled the city were laden with foodstuffs on their return trips. Temporary distress resulting from shortage of water was soon relieved by the collection of seepage from the broken mains



SEISMOGRAPH RECORD OF THE SALVADOR EARTHQUAKE.

This record is from the instrument deposited in the American Museum of Natural History, New York City, by the New York Academy of Sciences. It shows the vibrations of two separate needles—those of the north-south needle being at the left of the photograph and those of the east-west needle at the right. The north-south needle indicated that the shock was felt in New York City on the night of June 7, 1917, at 5 minutes and 20 seconds past 8 o'clock, while the east-west needle began to register at 6 minutes past 8 o'clock. The time of the greatest intensity of the shock as here indicated by wide vibrations was at 8 minutes and 30 seconds past 8 o'clock.

and by the utilization of artesian wells.

The outflow of the volcanic eruption, while abundant, caused comparatively little damage, since it was largely confined to uninhabited regions. Eight vents opened on the west side of the mountain, sweeping the slope with a stream of lava. A number of coffee plantations on the flanks of the stream were destroyed and, for a distance of two kilometers near Acajutla, the railroad was covered with lava to a depth of 30 feet. For the most part, the region affected is identical with that covered by the last great eruption occurring in 1674. It is said that in some places the old flow has been lifted bodily upon the new.

The San Salvador region is perhaps more frequently visited by earthquakes than any other section of America. In 1873, a shock probably equal in severity to the present one occurred, while more moderate tremors are of frequent occurrence. The accompanying record shows the intensity and duration of the shock of June 7 as recorded in New York City by the seismograph in the American Museum of Natural History.

SCIENTIFIC ITEMS

WE record with regret the death of James Mason Crafts, distinguished for his chemical researches and for a time president of the Massachusetts Institute of Technology; of Julius Otto Schlotterbeck, dean of the College of Pharmacy of the University of Michigan, and of T. McKenny Hughes, F.R.S., Woodwardian professor of geology in the University of Cambridge.

A MEMORIAL tablet to the late Dr. S. Weir Mitchell, distinguished as physiologist, physician and man of letters, was unveiled at the recent commencement exercises of the University of Pennsylvania.—A portrait of the late Professor Raphael Meldola is being painted by Mr. Solomon J. Solomon, in order that copies may be presented to the Royal Society and the Institute of Chemistry.—A memorial tablet, including a medallion portrait of the late Sir William Ramsay, is to be erected in the University of Glasgow, of which he was a graduate and teacher.

THE late Mr. W. Hudson Stephens, of Lowville, N. Y., a life member of the American Association for the Advancement of Science since its eighteenth meeting held in Salem in 1869, by the terms of his will has bequeathed the sum of $5,000 to the association.

THE will of the late Colonel Oliver H. Payne provides bequests of more than $7,000,000 to charitable and educational institutions. The largest gifts are to Yale University, Lakeside Hospital, Cleveland, and the New York Public Library, each of which will receive $1,000,000. An endowment of $500,000 is bequeathed to the Cornell University Medical College. Other gifts include: Phillips Academy, Andover, Mass., $500,000; St. Vincent's Charity Hospital, Cleveland, $200,000; Cleveland Jewish Orphans Asylum, $200,000; Hamilton College, Clinton, N. Y., $200,000, and the University of Virginia, $200,000.